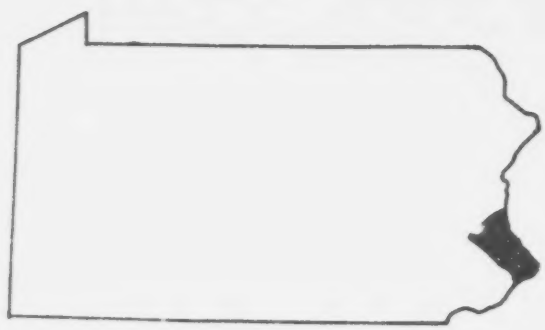
FLOOD INSURANCE STUDY

TOWNSHIP OF BRISTOL, PENNSYLVANIA
BUCKS COUNTY



REVISED
JUNE 4, 1990

Federal Emergency Management Agency

COMMUNITY NUMBER - 420984

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program (NFIP) have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

Part or all of this FIS may be revised and republished at any time. In addition, part of this FIS may be revised by the Letter of Map Revision (LOMR) process, which does not involve republication or redistribution of the FIS. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS components.

Initial Flood Insurance Study Effective Date: September 29, 1978

Flood Insurance Study Revised: June 4, 1990

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PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

FLOOD INSURANCE STUDY
TOWNSHIP OF BRISTOL, PENNSYLVANIA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Township of Bristol, Bucks County, Pennsylvania, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in their efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses in this study represent a revision of the original analyses prepared by Gannett, Fleming, Corddry and Carpenter, Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. H-3813. The work for the original study was completed in June 1977. The hydrologic and hydraulic analyses for the tidal flooding of the Delaware River in this revision were prepared by the Philadelphia District of the U. S. Army Corps of Engineers (COE). The work for this study was completed in April 1988.

1.3 Coordination

The identification of streams requiring detailed study was done at a meeting attended by personnel of Gannett, Fleming, Corddry and Carpenter, Inc. (study contractor), FEMA, and representatives of the community in March 1975. Study areas were finalized at a Consultation and Coordination Officer's (CCO) meeting in November 1975. On August 30, 1977, the results of the study were reviewed at a final CCO meeting attended by personnel of the study contractor, FEMA, and community officials.

Hydrologic analyses and flood profiles for Neshaminy Creek were coordinated with those developed by the study contractor for the adjacent community of Bensalem Township. Hydrologic analyses and flood profiles for Mill Creek were coordinated with those developed by the study contractor for the adjacent communities of Middletown Township and Bristol Borough. Hydrologic analyses and flood profiles for Queen Anne Creek were coordinated and developed by the study contractor with the adjacent community of Middletown Township. Water-surface elevations for the Delaware River were coordinated with the Falls Township Flood Insurance Study prepared by the Delaware River Basin Commission (DRBC).

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Township of Bristol, Bucks County, Pennsylvania. The area of study is shown on the Vicinity Map (Figure 1).

The following streams were studied by detailed methods for their entire lengths within the community: Croydon Run, Croydon Tributary, Mill Creek, Black Ditch, and Queen Anne Creek (Newportville). The Delaware River was restudied by detailed methods for its entire length within the community. In addition, a tributary to Martins Creek, studied by the DRBC during preparation of the Flood Insurance Study for the Township of Falls, has its floodplain extending into the Township of Bristol (Reference 1). Information has been taken from the Flood Insurance Study for the Township of Falls to delineate the flood hazard area on the Flood Insurance Rate Map and Flood Boundary and Floodway Map for the Township of Bristol. In this revision the Delaware River was studied by detailed methods to update tidal flooding. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction.

Floods caused by the overflow of Tributary A to the Delaware River were studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the Township of Bristol.

2.2 Community Description

The Township of Bristol is located in eastern Bucks County, in southeastern Pennsylvania, approximately 20 miles northeast of the City of Philadelphia, Pennsylvania. The township is bordered by the Township of Falls and the Borough of Tullytown to the east, the Borough of Bristol and the Delaware River to the south, the Township

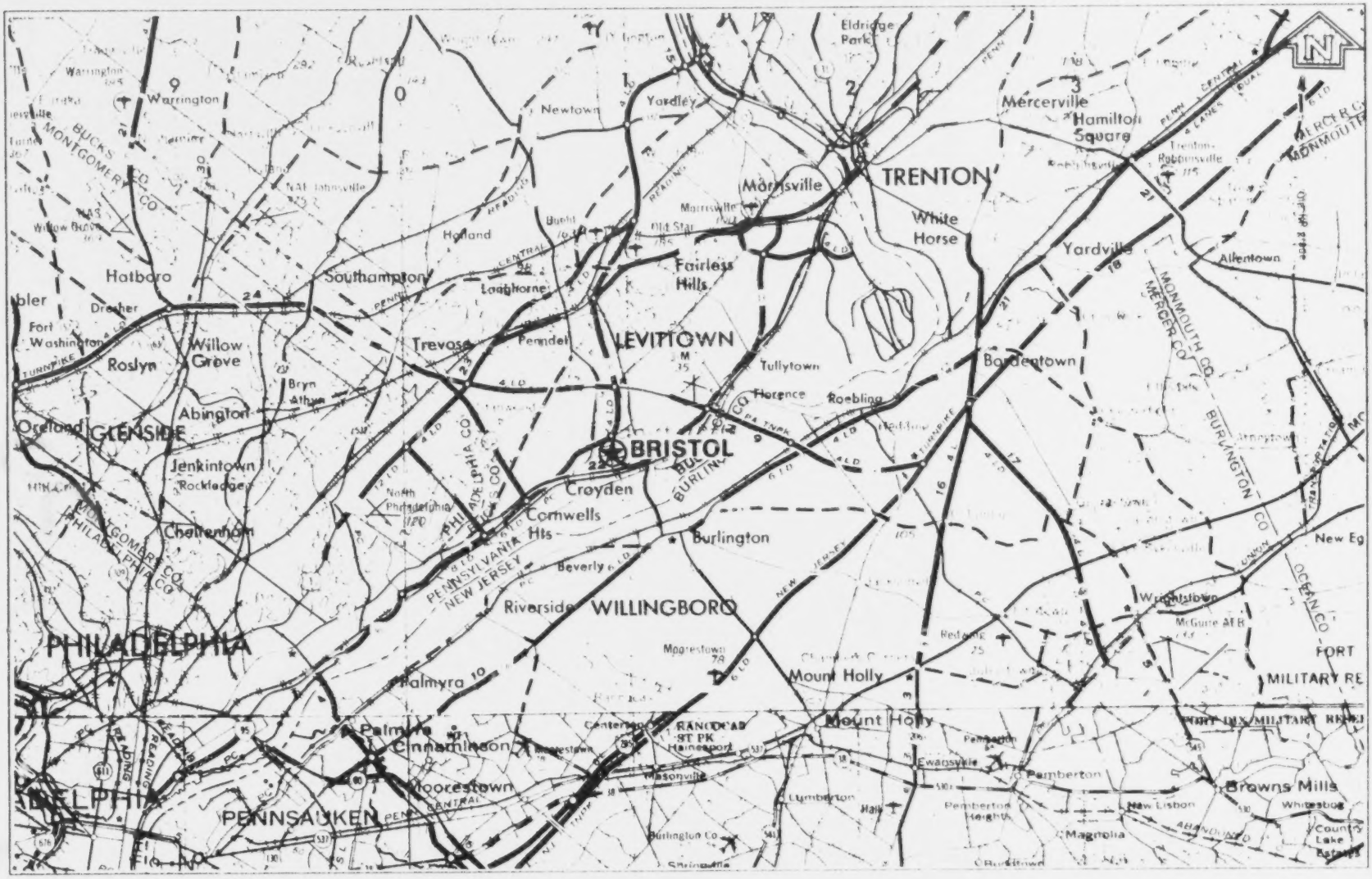


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF BRISTOL, PA

(BUCKS CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

of Bensalem to the west, the Township of Middletown to the north, and the Townships of Burlington and Florence, New Jersey, to the southeast, across the Delaware River. According to U. S. Census Bureau figures, the population of the township has increased from 59,298 in 1960 to 67,498 in 1970 (Reference 2).

The Delaware River, which forms a portion of the southern boundary of the Township of Bristol, is one of the principal rivers of the east coast of the United States. During its length it forms the boundaries between Pennsylvania and New York, Pennsylvania and New Jersey, and Delaware and New Jersey. The main stem of the river begins at the confluence of the east and west branches approximately 197 miles above Trenton, New Jersey. South of Wilmington, Delaware, the river empties its waters into the Delaware Bay. The floodplain of the Delaware River at the Township of Bristol contains commercial, industrial, and residential development. The drainage area of the Delaware River is 10,370 miles.

Neshaminy Creek, also studied by detailed methods, forms the western border of the township. Originating in Montgomery County, Pennsylvania, the creek flows into and through Bucks County for approximately 44 miles before draining into the Delaware River. The floodplains of Neshaminy Creek are relatively narrow due to the moderate to steep overbanks, which are covered with a variety of grasses, trees, and brush. Some residential development is affected by floodwaters. The drainage area totals 232 square miles.

Mill Creek originates in the Township of Middletown and meanders south through the Township of Bristol and the Borough of Bristol, forming the boundary between the two communities. It then flows into the Delaware River. Mill Creek has a length of 11 miles with a drainage area of 19.8 square miles.

Martins Creek Tributary, which has a drainage area of 11 square miles in the Townships of Falls and Bristol, parallels the northeast corporate limits of the Township of Bristol for approximately 3,000 feet. It then flows into Martins Creek in the Township of Falls.

Neshaminy Creek tributaries and their lengths studied in detail include Croydon Run (2.3 miles), Queen Anne Creek (through Newportville - 1.2 miles), and Croydon Tributary (0.8 mile). All three streams flow through developed areas and were studied by detailed methods.

The two Mill Creek tributaries and their lengths studied by detailed methods include another Queen Anne Creek (4.0 miles) and Black Ditch (3.0 miles).

English immigrants were the first permanent settlers of the area in the late 1600's. Bucks County, one of the original three counties in Pennsylvania, was formed in 1682, while the Township of Bristol

was one of five townships created in 1692. Agriculture was profitable in those early settlements due to both the excellent soil and proximity to the sizeable market of Philadelphia. Today the township is continuing to develop as shown by the 13.8 increase in population form 1960 to 1970. This development within the township and Bucks County can be expected to continue in the coming years (Reference 3).

The Township of Bristol, located within the Atlantic Coastal Plain Province, is characterized by level terrain. This narrow geographic region is crossed by many streams, most of them small, that rise from the adjacent Piedmont Province. The beds of unconsolidated or poorly consolidated sediments that underlie the Coastal Plain were once more widespread but have largely been removed from the area by erosion. The soil within the township has an average level of permeability and supports a variety of vegetation (Reference 4). An estimated 60 percent of the township has been developed by residential, commercial, or industrial concerns. This development is dispersed throughout the township. Major transportation arteries include Interstate Routes 95 and 276 (Pennsylvania Turnpike), U. S. Route 13, State Route 413, and CONRAIL.

The climate in southeastern Pennsylvania is typified as humid continental. Summer and winter temperatures average 73.2 degrees Fahrenheit (^{o}F) and 32.2^{o}F, respectively. Annual average precipitation of the region is 41.6 inches; recorded snowfall accounts for 9.6 inches of this total (Reference 5).

2.3 Principal Flood Problems

All streams considered in this study pose varying degrees of flood risk to residential and industrial areas within the township. In addition to susceptibility to fluvial flood events caused by runoff from general rainfall, the Township of Bristol is also subject to tidal flooding on the Delaware River and the lower reaches of its tributaries caused by extreme high tides, hurricane activity, and tropical storms. The extent of this risk is illustrated by major historical storms that occurred in 1903, 1933, and 1955. The greatest flood discharge of record on the Delaware River at Trenton, New Jersey, resulted from hurricanes Connie and Diane, which occurred one week apart in August 1955. The rainfall accompanying Hurricane Connie was in excess of five inches and was of similar intensity during Hurricane Diane, in which rainfall averaged 4.5 inches throughout the Delaware River watershed. The coincidental nature of these storms produced a high rate of runoff into streams already flowing near capacity. The discharge of 329,000 cubic feet per second (cfs) is currently estimated to be that of a 200-year recurrence interval flood at the gage at Trenton (upstream of tidal effect) by the COE and the U. S. Geological Survey (USGS). Over 100 lives were lost and 114 million dollars in damage occurred in Pennsylvania during these two hurricanes (References 6 and 7).

The past history of flooding of the streams within the township indicates that flooding may occur during any season of the year. Most major floods have occurred during the spring and summer months and are usually associated with tropical storms moving along the Atlantic Coastline.

During the 1955 flood, Neshaminy Creek attained its highest recorded discharge of 49,300 cfs and a stage of 22.84 feet at the Langhorne, Pennsylvania gage (References 8, 9, and 10). The discharge associated with this flood is estimated to have a recurrence interval of 175 years when the effects of regulation are not considered. Limited information is available concerning past flooding on the small tributaries studied in detail within the township. Because no discharge records are available for these streams, no recurrence intervals have been assigned to past floods in these areas.

The tidal surges that occur on the Delaware River during coastal storms are the primary cause of flooding from the Delaware River within the Township of Bristol. Tidal flooding along the Delaware River also causes flooding of certain tributaries within the township. Flooding along Croydon Tributary downstream of a point approximately 0.8 mile above its mouth, for example, is controlled entirely by backwater effects from the Delaware River.

2.4 Flood Protection Measures

There are a number of dams and reservoirs within the Neshaminy Creek watershed that aid in alleviating potential flooding. Presently existing are five Soil Conservation Service (SCS) dams, the effects of which have been included in the hydrologic analyses conducted for this study. Three of the dams, PA-611, PA-612, and PA-616, are single-purpose flood protection structures that provide floodwater storage capacities of 1,974 acre-feet, 327 acre-feet, and 1,794 acre-feet, respectively (Reference 11). PA-611 is located on Little Neshaminy Creek; PA-612 is located on Mill Creek; and PA-616 is located on Pine Run. All three structures are located outside the corporate limits of the Township of Bristol, in Bucks County. The remaining two dams, PA-617 and PA-620, are multiple-purpose structures that provide flood protection, recreational, and water-supply functions. The floodwater storage capacities afforded by the structures are 3,500 acre-feet and 1,965 acre-feet, respectively (Reference 11). PA-617 is located on North Branch Neshaminy Creek, while PA-620 is located on Core Creek. Both structures are located outside the corporate limits of the Township of Bristol, in Bucks County. PA-621 is currently under construction on a tributary of Neshaminy Creek; however, it will control only 3.04 square miles of the Neshaminy Creek Basin and will not substantially reduce the discharge until the remaining four proposed dams are completed.

There are five flood control dams on various tributaries of the Delaware River that help reduce flooding in the Township of Bristol. These include the Jadwin Dam, built in 1959, and the Prompton Reservoir, built in 1960, both on the Lackawana River near

Honesdale, Pennsylvania; the Walter Reservoir, built in 1961 on the Lehigh River; Beltzville Reservoir, built in 1969, on Pohopoco Creek; and the Nockamixon State Park Dam near Ottsville, Pennsylvania, built in 1973, which helps control flooding from Tohickon Creek. Six other dams are planned for the Delaware River. These include the Aquashicola Reservoir to be built on the Aquashicola Creek near Palmerton, Pennsylvania; the Tocks Island Reservoir to be built near Stroudsburg, Pennsylvania, on the Delaware River; the Paulina Dam to be built on Paulin Kill near Blairstown, New Jersey; and two dams on the Musconetong River, one to be located near Hackettstown and the other near New Hampton in New Jersey (Reference 1). The effects of these dams have been considered in the analyses for this study.

There are also non-structural measures being utilized to aid in the prevention of future flood damage. These are in the form of local land-use regulations adopted from the Code of Federal Regulations, Title 24, Chapter 10, FIA, Parts 1910.3A and 1910.3B, which control building within areas that have a high risk of flooding (Reference 12).

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency and peak elevation-frequency relationships for each flooding source studied in detail affecting the community.

Recorded flood-flow frequency data for Neshaminy Creek were based on statistical analysis of discharge records covering a 38-year period at the Langhorne gaging station (No. 01465500) operated by the USGS (References 8, 9, and 10). This analysis followed the standard log-Pearson Type III method, as outlined by the Water Resources Council (Reference 13). The resulting flows were then modified to account for the effects of watershed regulation using an empirical relationship which relates controlled and natural drainage areas to discharge values (Reference 14).

For the detailed study of Mill Creek, Black Ditch, and Queen Anne Creek, the hydrologic analysis was a modification of the SCS procedure designated in this study as "McSparran Tp, Condition III," which relates basin characteristics to stream flow characteristics (Reference 15).

For the detailed study of Croydon Tributary, the hydrologic analysis was a modification of the SCS procedure outlined in this study as "Kirpick Tc, Condition III," which relates basin characteristics to stream flow characteristics (Reference 16).

For the detailed study of Croydon Run and Queen Anne Creek (Newportville), the hydrologic analysis was a modification of the SCS procedure, Technical Release No. 55, "Urban Hydrology for Small Watersheds, Condition III," which relates basin characteristics to stream flow characteristics (Reference 17). Peak flood discharges for the detailed study of Croydon Run were modified downstream of the CONRAIL embankment to account for the storage capacity produced by the embankment. The adjusted discharges were selected based upon an analysis using the COE HEC-1 computer program for hydrograph analysis (Reference 18).

The hydrologic analyses conducted on Martins Creek Tributary were performed by the DRBC as part of the Flood Insurance Study for the Township of Falls (Reference 1). The flood-flow frequency relationships for Martins Creek Tributary were determined using a modified Rational Method. The Rational Method results were adjusted to simulate actual field conditions and were correlated with a regional method (Reference 19).

Flood discharges for the approximate study of Tributary A were determined using a modification of the SCS procedure, Technical Release No. 55, "Urban Hydrology for Small Watersheds, Condition III," which relates basin characteristics to stream flow characteristics (Reference 17).

A summary of the drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 1, "Summary of Discharges."

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
NESHAMINY CREEK					
At confluence with the Delaware River	233	20,658	34,098	41,103	60,973
At upstream corporate limits	215	19,800	33,000	38,600	56,500
MILL CREEK					
At confluence with the Delaware River	21.5	3,250	4,550	5,250	6,375
At Route 213 Bridge	2.8	956	1,499	1,758	2,367
MARTINS CREEK TRIBUTARY NO. 1					
At intersection of floodplain with Bristol Township	11	700	900	1,000	1,030
QUEEN ANNE CREEK					
At confluence with Mill Creek	7.0	877	1,244	1,401	1,778
At upstream corporate limits	5.4	849	1,199	1,345	1,699
BLACK DITCH					
At confluence with Mill Creek	3.3	1,314	1,793	2,013	2,716
At Mill Creek Road	1.1	765	1,103	1,349	1,672
CROYDON RUN					
At confluence with Neshaminy Creek*	2.47	121	138	148	173
At Newport Road	1.40	193	347	417	585
QUEEN ANNE CREEK (NEWPORTVILLE)					
At confluence with Neshaminy Creek	0.65	440	611	708	863
At Groveland Avenue	0.38	322	447	517	631
CROYDON TRIBUTARY					
At confluence with Neshaminy Creek	0.54	402	567	638	796
At Excelsior Avenue	0.30	117	164	204	265

*Discharge considers storage capacity produced by CONRAIL embankment.

In this revision, the elevation versus frequency relationships adopted for locations within the Delaware River estuary are based on an analysis of gage records for several selected tide gages. The tide gages used in the analysis were Lewes, Delaware; New Castle, Delaware; Philadelphia, Pennsylvania; Burlington, New Jersey; and Trenton (Municipal Pier), New Jersey (Reference 4).

To obtain a consistent set of annual peak stages, it was necessary to consider that the mean sea level has been rising at a long-term average rate of approximately 0.014 feet per year off the coast of Delaware Bay. Observed annual peak stages for Lewes, New Castle, Philadelphia, and Burlington (locations at which the tidal influence on annual peaks was significant) were adjusted to 1979 by increasing the observed peak by 0.014 feet multiplied by the difference in years between 1979 and the year the peak was observed. Elevation versus frequency curves were developed for the five gage locations based on a graphical frequency analysis of the adjusted annual peak stages using Weibul plotting positions with high outlier adjustments based on procedures outlined in USGS Bulletin 17A (Reference 5).

Table 2, "Summary of Stillwater Elevations," shows the relationship between frequency and tide elevations for gages at Trenton, Burlington, and Philadelphia. Between these gage locations, elevation-frequency relationships were developed using a graphical interpolation procedure based on trends shown by a profile plot of observed peak stages of historic flood events. The stillwater elevations for the 10-, 50-, 100-, and 500-year floods have been determined for the Delaware River and are summarized in Table 2.

TABLE 2 - SUMMARY OF STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (feet) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
DELAWARE RIVER				
At Trenton Municipal Pier tide gage	11.8	17.7	20.3	25.9
At upstream corporate limits	8.8	11.4	12.3	15.3
At downstream corporate limits	8.3	9.8	10.8	13.3
At Burlington tide gage	8.5	10.2	11.0	13.6
At Philadelphia tide gage	7.6	9.2	10.0	12.1

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from all sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

A hydraulic model of fluvial flows was developed for the Delaware River between Rancocas Creek and the Calhoun Street bridge in the City of Trenton. This model produced results that were lower than the tidal flood elevations for the same recurrence intervals. Because of coincident frequency problems associated with modeling flows and tides, and the limited applicability of the hydraulic model in estuaries, the stillwater elevations for the Delaware River were used as the flood elevations (Reference 20).

Composite cross sections for the backwater analysis of the streams studied by detailed methods were obtained from aerial photographs taken in February 1973, at a scale of 1:12,000; the below-water sections were obtained by field measurement (Reference 21). All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Water-surface elevations of floods of the selected recurrence intervals were computed using the COE HEC-2 step-backwater computer program (Reference 22). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. Starting water-surface elevations for Neshaminy Creek and Mill Creek were taken from the Delaware River profiles. Starting elevations for Queen Anne Creek (Newportville), Croydon Run, and Croydon Tributary were obtained from the Neshaminy Creek profiles, while the starting elevations for Queen Anne Creek and Black Ditch were taken from the Mill Creek profiles.

Water-surface profiles for the tributary to Martins Creek were obtained from the Flood Insurance Study for the Township of Falls conducted by the DRBC (Reference 1).

Channel roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment based on field observations of the streams and floodplain areas. Roughness values for the main channels of the streams studied in detail are as follows:

Flooding Source	Roughness Coefficient	
	Channel "n"	Overbank "n"
Neshaminy Creek	0.035-0.100	0.025-0.100
Mill Creek	0.050-0.080	0.030-0.080
Martins Creek Tributary	0.013-0.050	0.050-0.120
Queen Anne Creek	0.070-0.080	0.035-0.075
Black Ditch	0.070-0.080	0.030-0.080
Croydon Run	0.050-0.070	0.040-0.070
Queen Anne Creek (Newportville)	0.060	0.035-0.060
Croydon Tributary	0.060	0.040-0.060

The acceptability of all assumed hydraulic factors, cross sections, and hydraulic structure data was checked by computations that duplicated historic floodwater profiles.

For the stream studied by approximate methods, the limits of the 100-year flood were developed from normal depth calculations based upon information obtained from field reconnaissance and available topographic mapping (Reference 23).

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing floodplain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For the flooding sources studied in detail, the 100- and 500-year floodplain boundaries have been delineated using topographic maps (Reference 24).

For the stream studied by approximate methods, the boundaries of the 100-year floodplain were determined using normal depth calculations in conjunction with the topographic maps referenced previously (Reference 25).

The 100- and 500-year floodplain boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself.

One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as a minimum standard that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the floodplain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 3). All or portions of the floodway widths for Neshaminy and Mill Creeks extend beyond the corporate limits.

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary has been shown. No floodway calculations were performed for the Delaware River in the Township of Bristol since the floodway concept is not applicable to areas of permanent tidal inundation.

The area between the floodway and 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2.

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail in the Township of Bristol.

5.1 Reach Determinations

Reaches are defined as sections of floodplain that have relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following tabulation for more than 20 percent of the reach:

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH[2] (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FT.)
Neshaminy Creek							
A	1,110	359/149	3,737	11.0	4.5	3.7[3]	0.8
B	3,500	281/111	4,035	10.2	7.5	7.4[3]	0.1
C	4,705	372/192	5,927	6.9	9.4	9.4[4]	0.0
D	5,820	298/118	4,270	9.6	9.5	9.5[4]	0.0
E	7,090	702/512	9,152	4.5	11.1	10.7[4]	0.4
F	7,790	245/105	4,505	9.1	11.7	11.4[4]	0.3
G	8,370	420/300	7,045	5.8	13.4	13.2[4]	0.2
H	9,730	346/156	5,689	7.2	13.8	13.6[4]	0.2
I	11,200	602/152	8,875	4.6	14.8	14.4[4]	0.4
J	12,530	418/158	6,614	6.2	15.1	14.7[4]	0.4
K	14,110	389/159	6,625	6.2	16.8	16.0[4]	0.8
L	15,410	465/245	7,689	5.4	17.3	16.6[4]	0.7
M	17,270	555/365	8,002	5.1	18.0	17.2[4]	0.8
N	18,170	489/340	6,640	6.2	18.2	17.4[4]	0.8
O	19,180	977/257	11,302	3.6	19.1	18.2[4]	0.9
P	20,600	470/190	5,443	7.6	19.2	18.3[4]	0.9
Q	21,560	421/181	5,337	7.7	20.5	19.7[4]	0.8
R	22,140	307/127	4,173	9.8	20.6	19.9[4]	0.7
S	22,910	304/184	4,671	8.3	22.1	21.4	0.7
T	23,750	258/188	3,767	10.2	22.7	22.1	0.6

[1]FEET ABOVE CONFLUENCE WITH DELAWARE RIVER
[2]WIDTH/WIDTH WITHIN CORPORATE LIMITS
[3]DOES NOT CONSIDER BACKWATER EFFECTS FROM DELAWARE RIVER
[4]ELEVATIONS SHOWN ON FLOOD PROFILES REFLECT INFLUENCE OF DELAWARE RIVER BACKWATER

TABLE 3

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA
(BUCKS CO.)

FLOODWAY DATA

NESHAMINY CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FT.)
Mill Creek							
A	660	631/41[2]	5,955	0.9	12.2	11.2	1.0
B	1,240	342/282[2]	2,086	2.5	12.2	11.2	1.0
C	1,440	92/47[2]	1,028	5.1	12.3	11.3	1.0
D	2,150	105/60[2]	1,009	5.2	12.7	11.7	1.0
E	3,250	80/40[2]	808	6.5	13.6	12.9	0.7
F	3,390	92/57[2]	976	5.4	14.0	13.4	0.6
G	3,730	84/64[2]	783	6.7	14.1	13.6	0.5
H	4,210	189/0[2]	1,740	3.0	19.2	18.9	0.3
I	4,770	194/40[2]	1,460	3.5	19.4	19.0	0.4
J	5,150	46	542	9.4	20.3	20.0	0.3
K	5,390	53	594	8.6	21.1	20.6	0.5
L	5,810	206	1,067	4.8	22.6	22.5	0.1
M	6,440	358	2,225	2.3	23.4	23.0	0.4
N	6,740	393	2,388	2.1	23.7	23.1	0.6
O	8,410	601/330[2]	4,491	1.1	24.2	23.5	0.7
P	10,075	585	4,409	1.1	24.2	23.6	0.6
Q	11,475	482	2,600	1.9	24.4	23.7	0.7
R	12,975	107	831	6.0	24.9	24.2	0.7
S	13,205	198	1,606	3.1	26.6	25.9	0.7
T	14,745	508	3,900	1.2	27.0	26.4	0.6

[1]FEET ABOVE CONFLUENCE WITH DELAWARE RIVER
[2]WIDTH/WIDTH WITHIN CORPORATE LIMITS

TABLE 3

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA
(BUCKS CO.)

FLOODWAY DATA

MILL CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FT.)
Mill Creek (continued)							
U	15,305	181	1,293	3.5	29.0	28.1	0.9
V	16,815	477	2,018	1.9	29.9	29.1	0.8
W	17,715	128	723	5.3	30.2	29.5	0.7
X	18,065	114	775	4.9	32.0	31.1	0.9
Y	18,565	56	473	8.0	32.4	31.7	0.7
Z	19,585	92	697	5.5	35.6	34.7	0.9
AA	20,565	268	1,467	2.6	36.9	35.9	1.0
AB	21,165	211	926	4.1	37.2	36.3	0.9
AC	21,905	66	402	9.5	38.9	38.1	0.8
AD	22,765	237	1,433	2.4	41.7	40.7	1.0
AE	23,595	191	979	3.6	42.2	41.2	1.0
AF	24,495	201	939	3.7	43.2	42.3	0.9
AG	25,095	210	1,027	3.4	44.0	43.2	0.8
AH	25,325	186	1,233	2.8	45.0	44.0	1.0
AI	26,085	230	1,236	2.8	45.5	44.6	0.9
AJ	27,225	198	1,023	3.4	46.5	45.6	0.9
AK	27,765	97	446	5.5	47.0	46.1	0.9

[1]FEET ABOVE CONFLUENCE WITH DELAWARE RIVER

TABLE 3

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA
(BUCKS CO.)

FLOODWAY DATA

MILL CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FT.)
Queen Anne Creek							
A	70	63	285	4.9	44.5	44.0[2]	0.5
B	310	60	215	6.5	44.8	44.0[2]	0.8
C	740	70	326	4.3	46.6	46.3	0.3
D	1,240	60	382	3.7	47.6	47.0	0.6
E	8,040	124	578	2.4	58.8	58.3	0.5
F	8,520	90	367	3.7	59.1	58.7	0.4
G	9,490	97	390	3.5	61.0	60.6	0.4
H	10,610	84	366	3.7	63.9	63.1	0.8
I	10,810	43	364	3.8	66.1	65.5	0.6
J	11,190	88	546	2.5	66.6	65.9	0.7
Black Ditch							
A	520	222	748	2.7	24.2	23.2[2]	1.0
B	1,180	263	1,199	1.7	25.2	24.3[2]	0.9
C	1,680	254	1,070	1.9	25.6	24.7[2]	0.9
D	2,040	443	2,719	0.7	28.8	28.2	0.6
E	2,940	360	1,889	1.1	28.9	28.3	0.6
F	4,410	253	1,735	1.2	29.2	28.5	0.7
G	5,640	103	931	1.9	29.3	28.6	0.7

[1]FEET ABOVE CONFLUENCE WITH MILL CREEK
[2]DOES NOT CONSIDER BACKWATER EFFECTS FROM MILL CREEK

TABLE 3

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA
(BUCKS CO.)

FLOODWAY DATA

QUEEN ANNE CREEK AND BLACK DITCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FT.)
Black Ditch (continued)							
H	6,160	91	801	2.2	29.4	28.7	0.7
I	6,640	202	1,255	1.4	29.5	28.7	0.8
J	6,960	136	757	2.3	29.8	29.0	0.8
K	7,680	132	1,043	1.7	30.0	29.2	0.8
L	8,130	254	1,591	1.1	30.1	29.3	0.8
M	8,900	90	742	2.3	30.1	29.3	0.8
N	9,440	81	723	2.4	30.8	30.0	0.8
O	9,980	190	1,294	1.0	31.0	30.2	0.8
P	10,760	65	553	2.4	31.1	30.3	0.8
Q	11,100	68	576	2.3	31.2	30.3	0.9
R	11,580	219	968	1.4	31.4	30.6	0.8
S	12,320	146	683	2.0	31.6	30.7	0.9
T	12,700	203	1,184	0.9	31.8	30.9	0.9
U	12,930	84	563	1.9	31.8	30.9	0.9
V	13,480	101	556	1.9	31.9	31.0	0.9
W	13,790	144	705	1.5	32.1	31.2	0.9
X	14,670	128	646	1.7	32.3	31.4	0.9
Y	15,570	108	539	2.0	32.5	31.7	0.8

[1]FEET ABOVE CONFLUENCE WITH MILL CREEK

TABLE 3

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA
(BUCKS CO.)

FLOODWAY DATA

BLACK DITCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FT.)
Croydon Run							
A	1,560	21	51	2.9	8.1	7.3[2]	0.8
B	1,700	22	48	3.1	8.8	8.6[2]	0.2
C	3,590	24	104	1.4	18.0	17.2	0.8
D	4,110	20	80	1.9	18.3	17.6	0.7
E	5,330	447	2,278	0.3	28.8	28.0	0.8
F	6,590	516	3,093	0.2	28.8	28.0	0.8
G	7,800	351	1,879	0.3	28.8	28.0	0.8
H	8,250	397	1,978	0.3	28.8	28.0	0.8
I	8,900	859	3,183	0.2	28.8	28.0	0.8
J	9,550	1,406	5,266	0.1	28.9	28.1	0.8
K	11,010	1,059	4,131	0.1	28.9	28.1	0.8
L	11,120	723	3,698	0.1	28.9	28.1	0.8
M	11,380	1,096	5,226	0.1	28.9	28.1	0.8
N	11,980	1,294	5,443	0.1	28.9	28.1	0.8
O	12,120	975	3,261	0.1	28.9	28.1	0.8
P	14,020	121	134	3.1	31.1	30.6	0.5
Q	14,280	96	243	1.7	31.8	31.5	0.3
R	14,510	114	300	1.4	31.9	31.6	0.3
S	14,880	77	220	1.9	32.2	31.8	0.4
T	15,480	23	76	5.5	33.2	32.5	0.7

[1]FEET ABOVE CONFLUENCE WITH NESHAMINY CREEK
[2]DOES NOT CONSIDER BACKWATER EFFECTS FROM NESHAMINY CREEK

TABLE 3

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA
(BUCKS CO.)

FLOODWAY DATA

CROYDON RUN

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FT.)
Croydon Run (continued)							
U	15,730	24	94	4.4	34.3	33.4	0.9
V	15,950	630	3,325	0.1	35.2	34.2	1.0
Queen Anne Creek (Newportville)							
A	950	38	316	2.2	19.1	18.3	0.8
B	1,090	188	1,211	0.6	20.1	19.3	0.8
C	1,310	106	588	1.2	20.1	19.3	0.8
D	2,420	24	75	9.4	21.8	21.7	0.1
E	3,560	20	92	7.7	32.9	31.9	1.0
F	3,880	32	125	5.7	35.2	34.6	0.6
G	4,270	78	308	2.3	38.1	37.3	0.8
H	4,530	136	631	0.8	40.1	39.3	0.8
I	5,200	150	521	1.0	40.2	39.5	0.7
J	5,980	68	106	4.9	42.6	42.5	0.1
Croydon Tributary							
A	530	514	970	0.7	7.4	7.0[2]	0.4

[1]FEET ABOVE CONFLUENCE WITH NESHAMINY CREEK
[2]ELEVATIONS ON PROFILE REFLECT DELAWARE RIVER BACKWATER

TABLE 3

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA
(BUCKS CO.)

FLOODWAY DATA

CROYDON RUN, QUEEN ANNE CREEK (NEWPORTVILLE) AND CROYDON TRIBUTARY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FT.)
Croydon Tributary (continued)							
B	1,430	70	159	4.0	7.6	7.1[2]	0.5
C	2,810	226	748	0.9	13.1	12.2	0.9
D	3,140	48	251	2.5	13.2	12.3	0.9
E	3,640	48	246	2.6	13.5	12.6	0.9
F	3,890	186	546	1.2	13.7	12.8	0.9
G	3,980	278	461	1.4	13.7	12.8	0.9
H	4,540	268	1,269	0.2	13.8	12.9	0.9
I	5,790	461	1,989	0.1	13.8	12.9	0.9

[1]FEET ABOVE CONFLUENCE WITH NESHAMINY CREEK
[2]ELEVATIONS ON PROFILE REFLECT DELAWARE RIVER BACKWATER

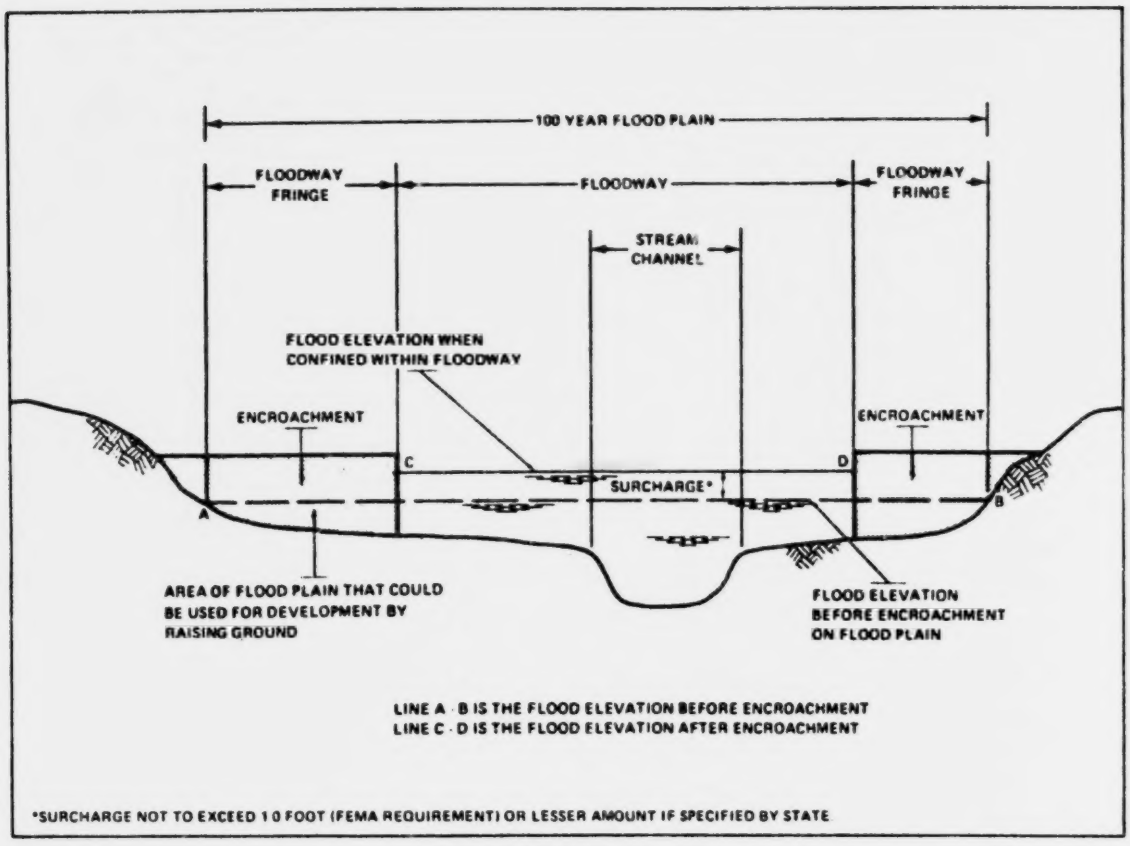
TABLE 3

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA
(BUCKS CO.)

FLOODWAY DATA

CROYDON TRIBUTARY


100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE

FLOODWAY SCHEMATIC Figure 2

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the flooding sources of the Township of Bristol are shown on the Flood Profiles (Exhibit 1) and summarized in Table 4.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Neshaminy Creek							
Reach 1	10	-3.4	-1.3	+4.4	035	A7	Varies
Reach 2	05-10	-5.0	-1.6	+4.7	050	A10	Varies
Mill Creek							
Reach 1	10	-3.1	-1.2	+3.2	030	A6	Varies
Reach 2	05-10	-1.5	-0.5	+0.9	015	A3	Varies
Martins Creek Tributary 1							
Reach 1	05	-1.0	-0.4	+0.2	010	A2	Varies
Queen Anne Creek							
Reach 1	05	-1.0	-0.3	+0.6	010	A2	Varies
Reach 2	05	-1.0	-0.3	+0.6	010	A2	Varies
Reach 3	05	-2.0	-0.7	+1.7	020	A4	Varies
Black Ditch							
Reach 1	05	-1.0	-0.3	+0.9	010	A2	Varies

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO THE NEAREST FOOT--SEE MAP

TABLE 4

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA
(BUCKS CO.)

FLOOD INSURANCE ZONE DATA

NESHAMINY CREEK, MILL CREEK, MARTINS CREEK TRIBUTARY 1, QUEEN ANNE CREEK, BLACK DITCH

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Croydon Run							
Reach 1	10	-0.3	-0.1	+1.2	005	A1	Varies
Reach 2	10	-2.3	-1.0	+3.0	025	A5	Varies
Reach 3	10	-0.8	-0.3	+0.7	010	A2	Varies
Queen Anne Creek (Newportville)							
Reach 1	10	-4.5	-1.8	+3.71	045	A9	Varies
Reach 2	10	-2.4	-1.1	+2.9	025	A5	Varies
Reach 3	05-10	-0.6	-0.2	+0.6	005	A1	Varies
Croydon Tributary							
Reach 1	10	-0.6	-0.3	+3.6	005	A1	Varies
Delaware River							
Reach 1	05-10	-3.0	-1.0	+2.7	025	A5	Varies

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO THE NEAREST FOOT--SEE MAP

TABLE 4

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA
(BUCKS CO.)

FLOOD INSURANCE ZONE DATA

CROYDON RUN, QUEEN ANNE CREEK, CROYDON TRIBUTARY AND DELAWARE RIVER

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one- half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.
Zones A1, A2, A3, A4, A5, A6, A7, A9, and A10:	Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding; not subdivided.

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding sources studied in detail in the community are shown in Table 4.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Township of Bristol is, for insurance purposes, the principal result of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

6.0 OTHER STUDIES

Flood Insurance Studies have been prepared for the Townships of Bensalem, Middleton, and Falls; the Townships of Florence and Burlington, New Jersey; and the Boroughs of Bristol and Tullytown (References 26, 27, 1, 28, 29, 30, and 31). The results of this study are in exact agreement with the results of those studies.

Due to its more up-to-date nature, this study supersedes the previously published Flood Insurance Study for the Township of Bristol (Reference 32).

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting FEMA, the Natural and Technological Hazards Division, Liberty Square Building (Second Floor), 105 South Seventh Street, Philadelphia, Pennsylvania 19106.

8.0 BIBLIOGRAPHY AND REFERENCES

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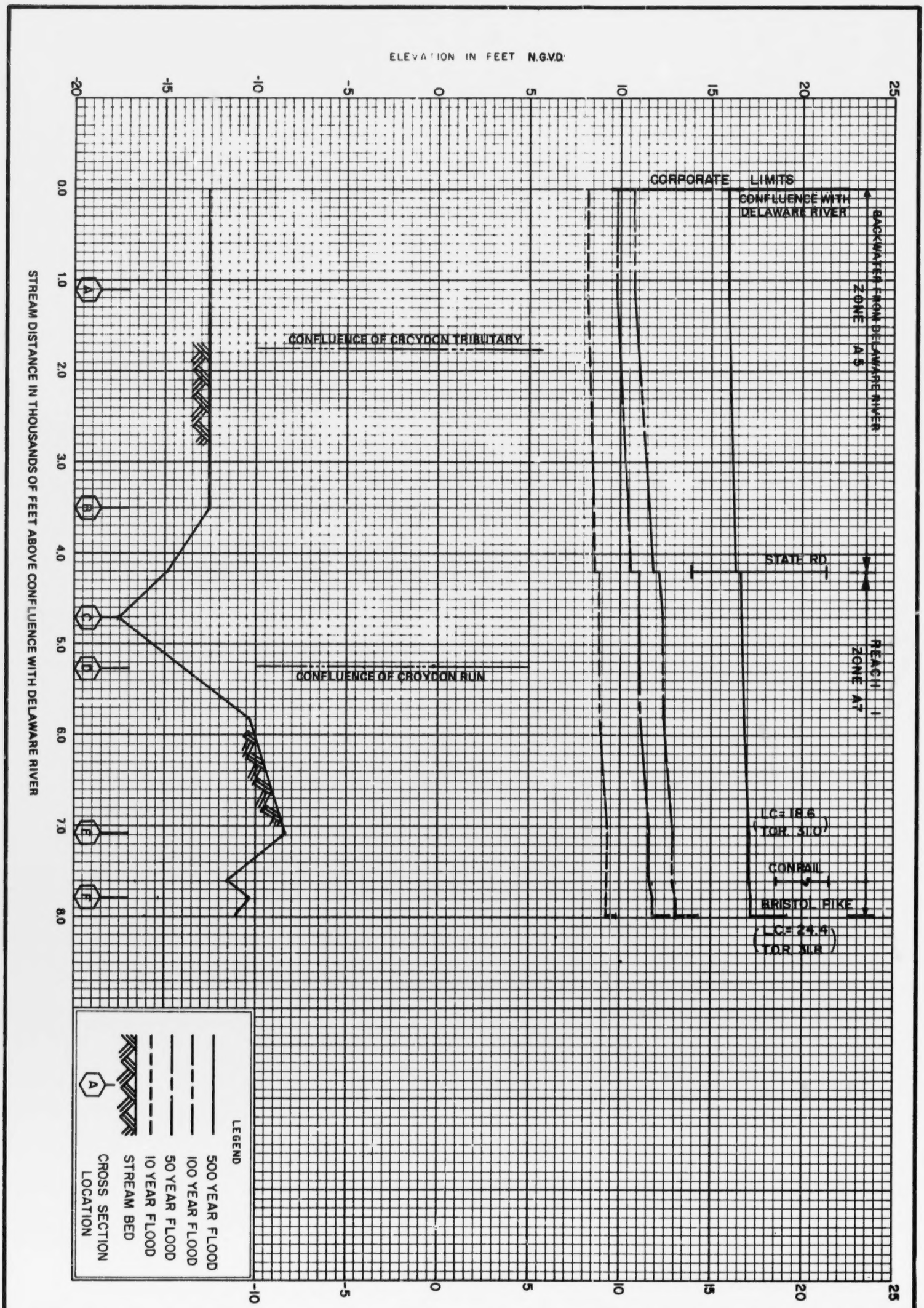
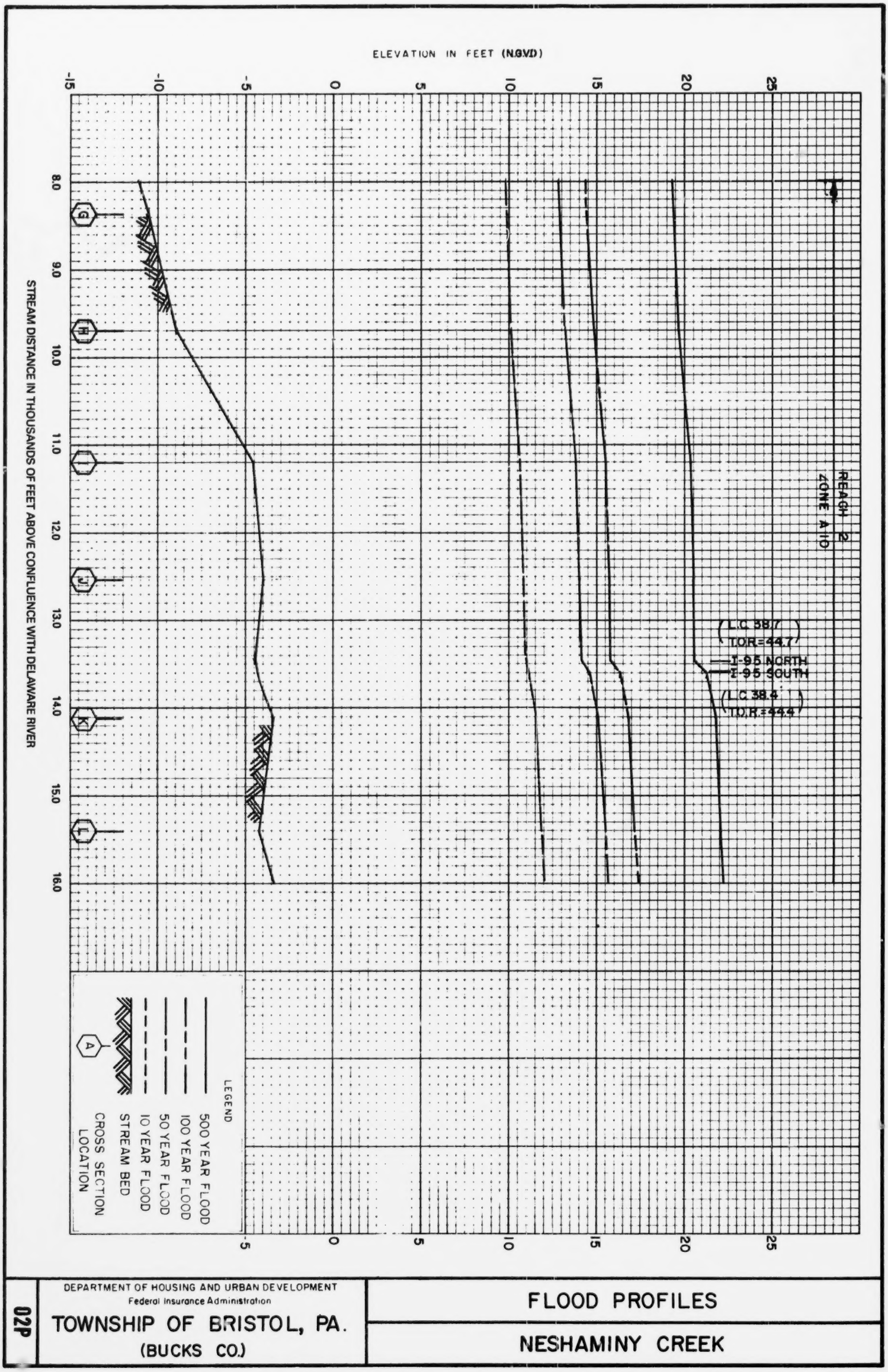


DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA.
(BUCKS CO.)

FLOOD PROFILES

NESHAMINY CREEK



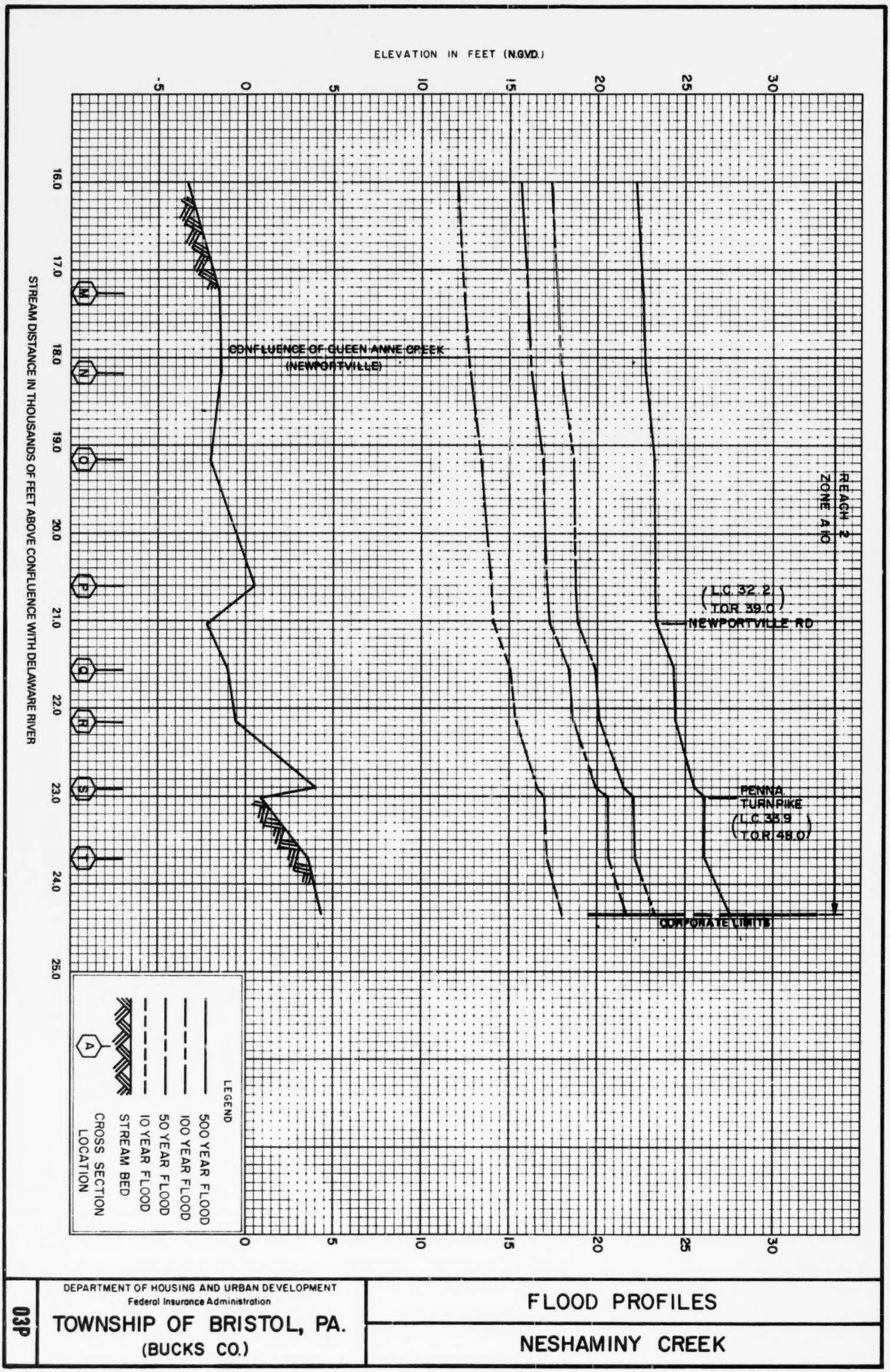
02P

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA.
(BUCKS CO.)

FLOOD PROFILES

NESHAMINY CREEK



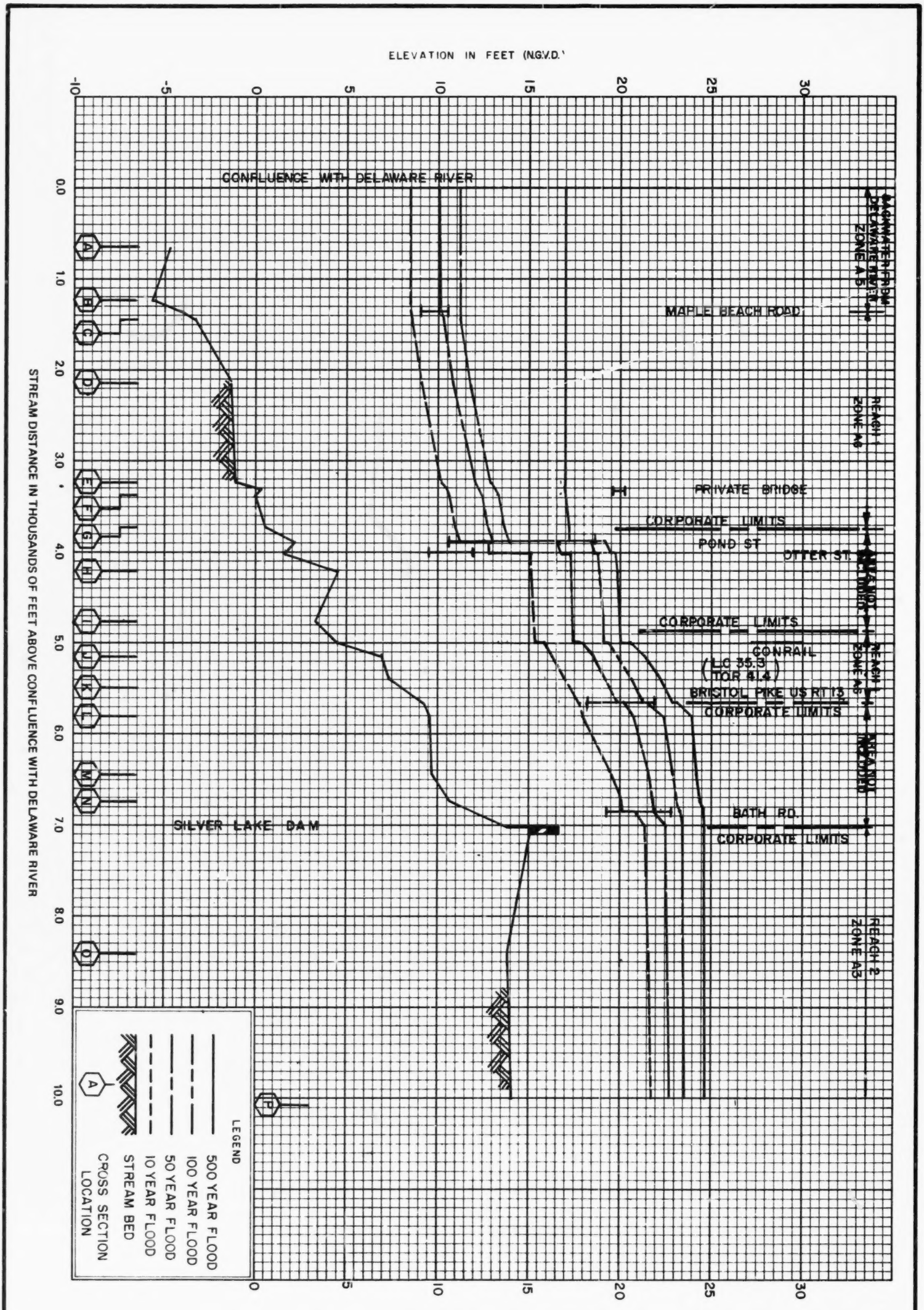
03P

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA.
(BUCKS CO.)

FLOOD PROFILES

NESHAMINY CREEK



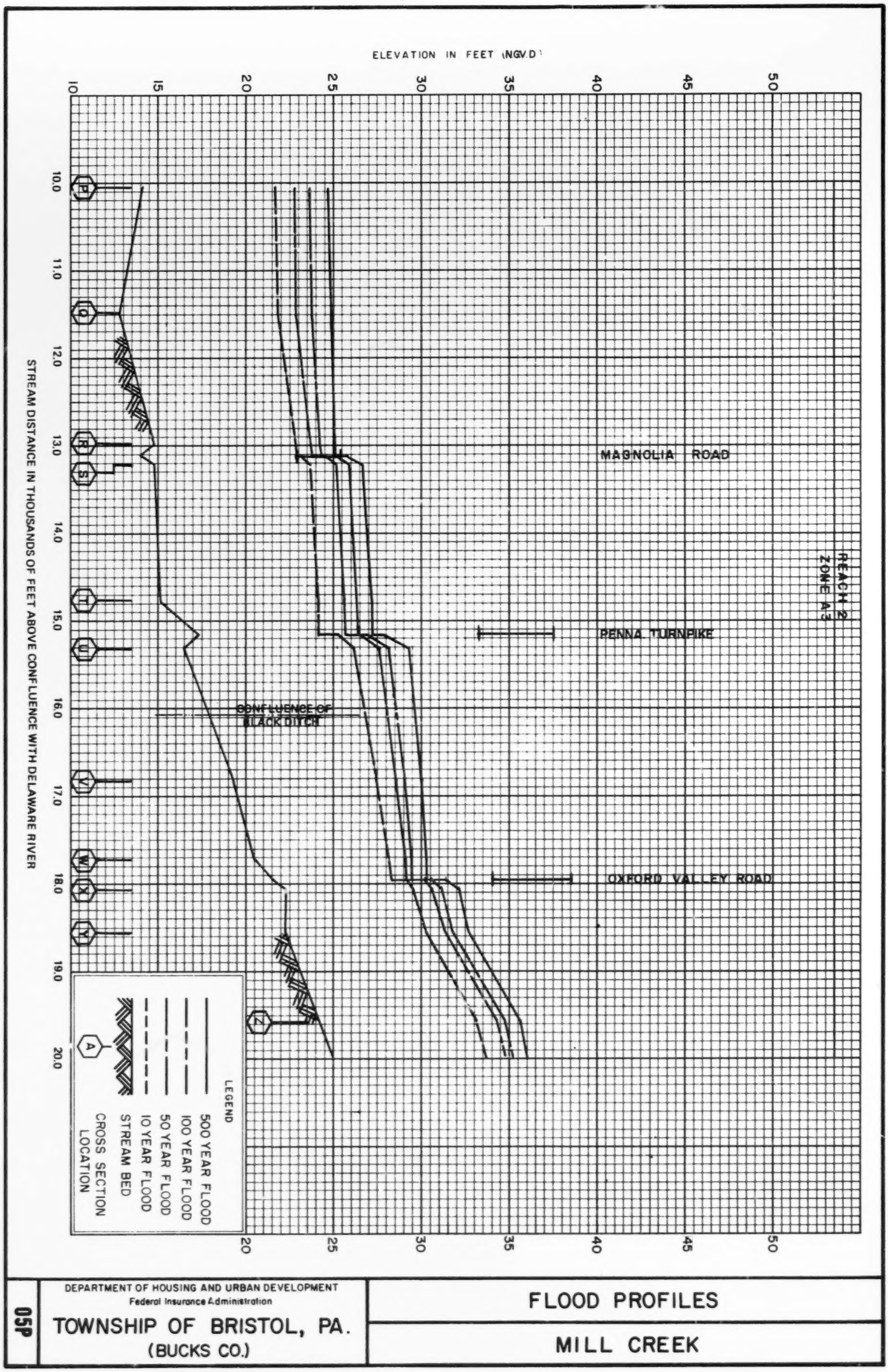
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA.
(BUCKS CO.)

04P

FLOOD PROFILES

MILL CREEK



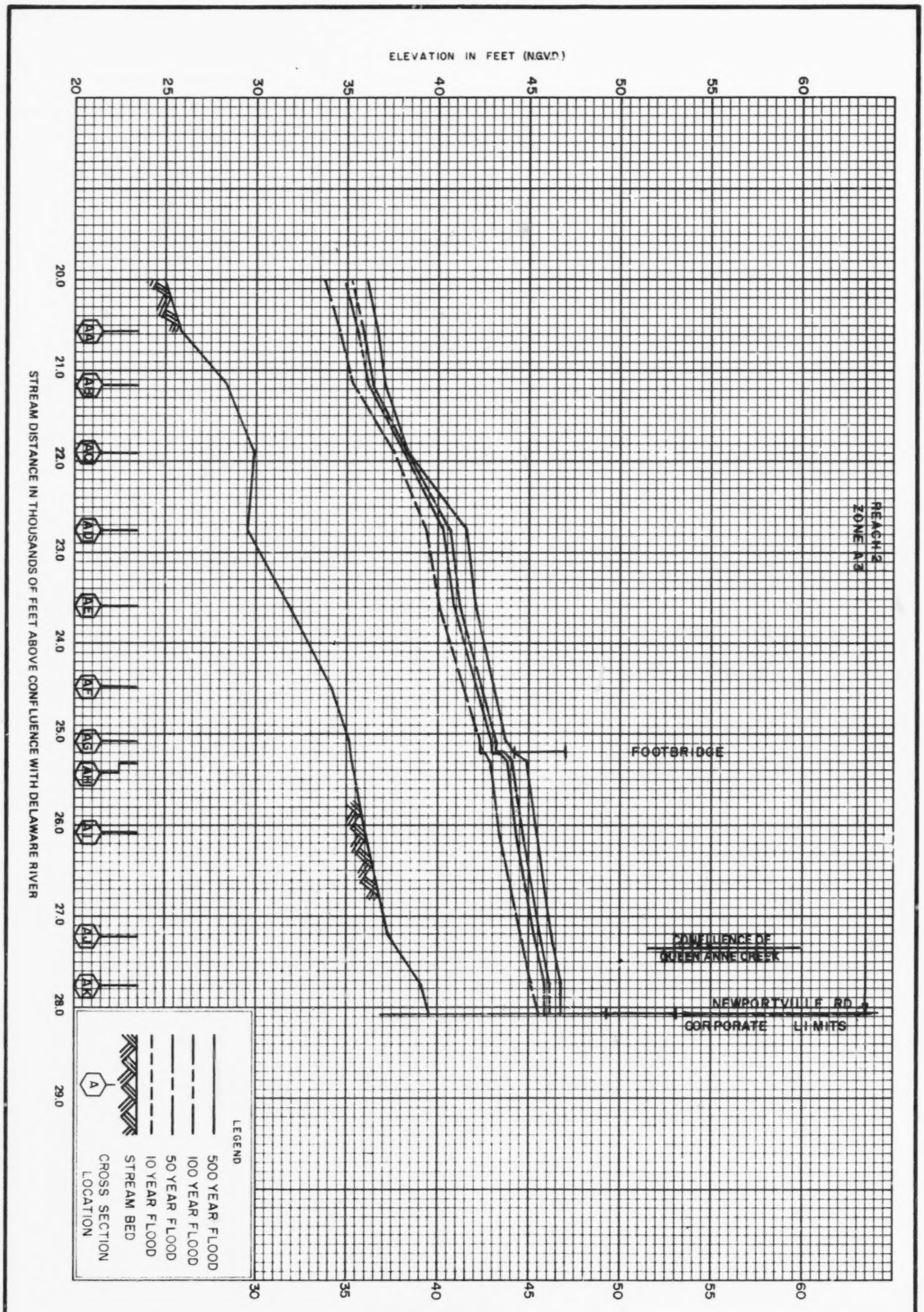
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA.
(BUCKS CO.)

05P

FLOOD PROFILES

MILL CREEK



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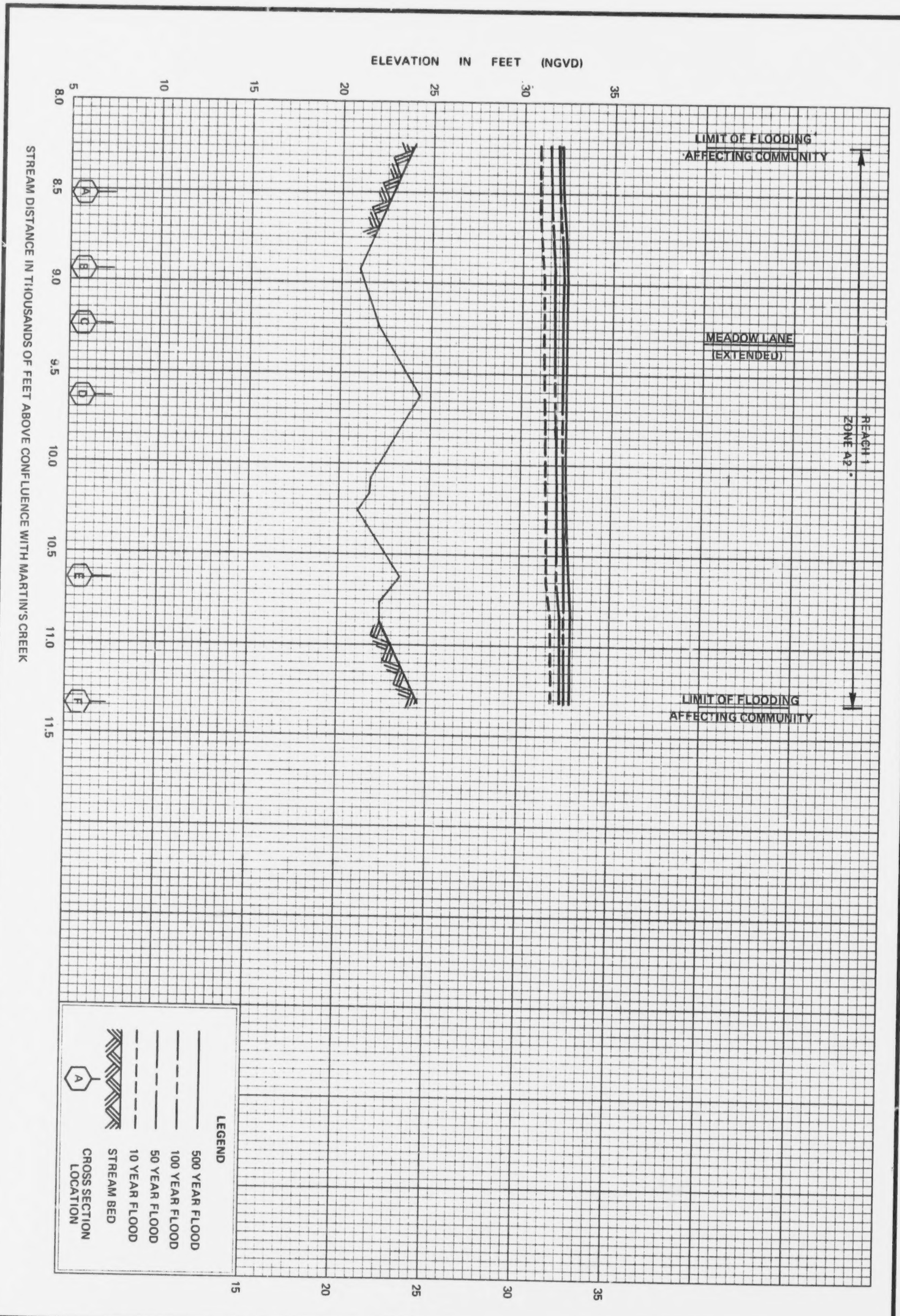


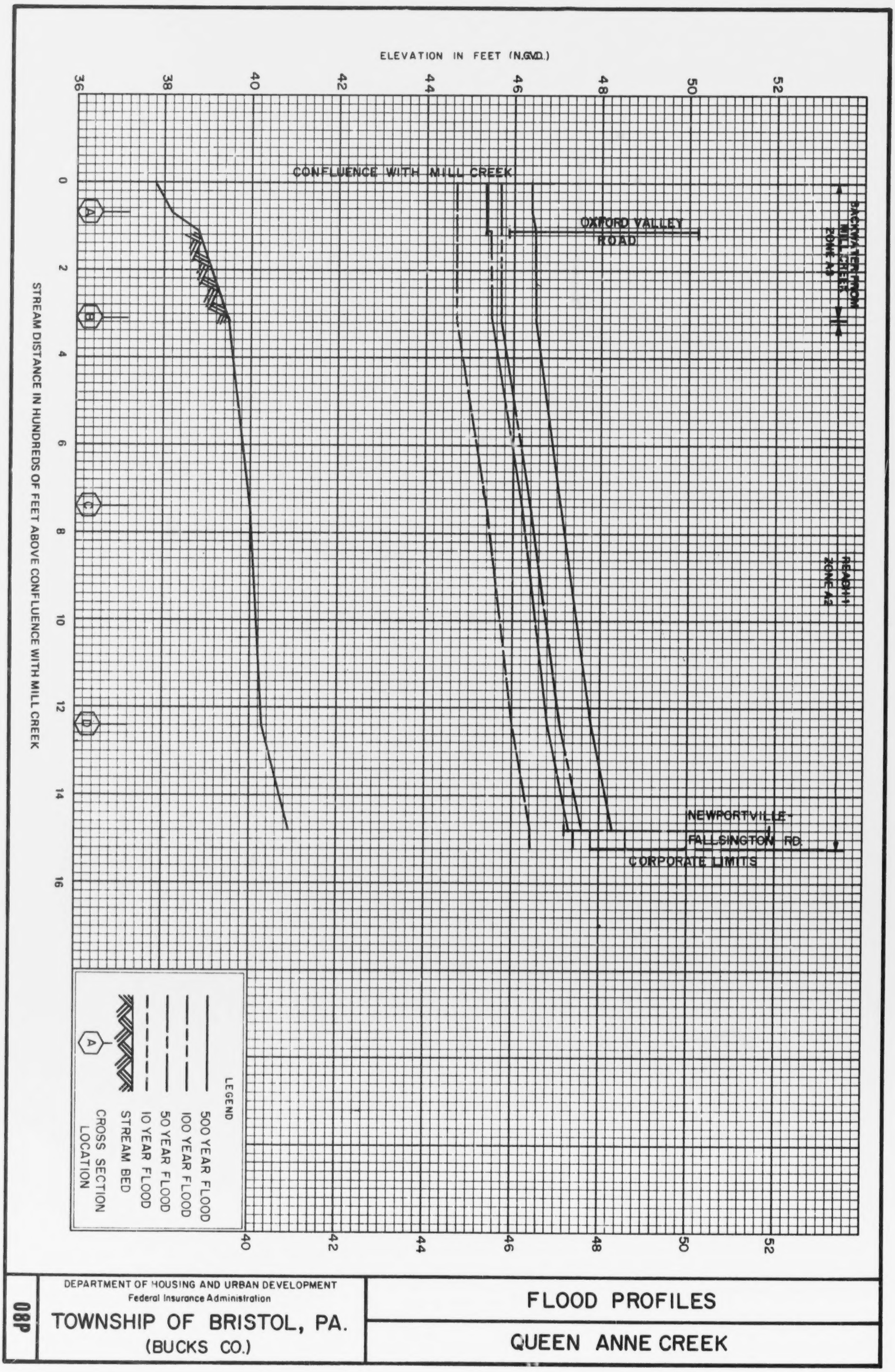
07P

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA.
(BUCKS CO.)

FLOOD PROFILES

MARTINS CREEK TRIBUTARY NO.1



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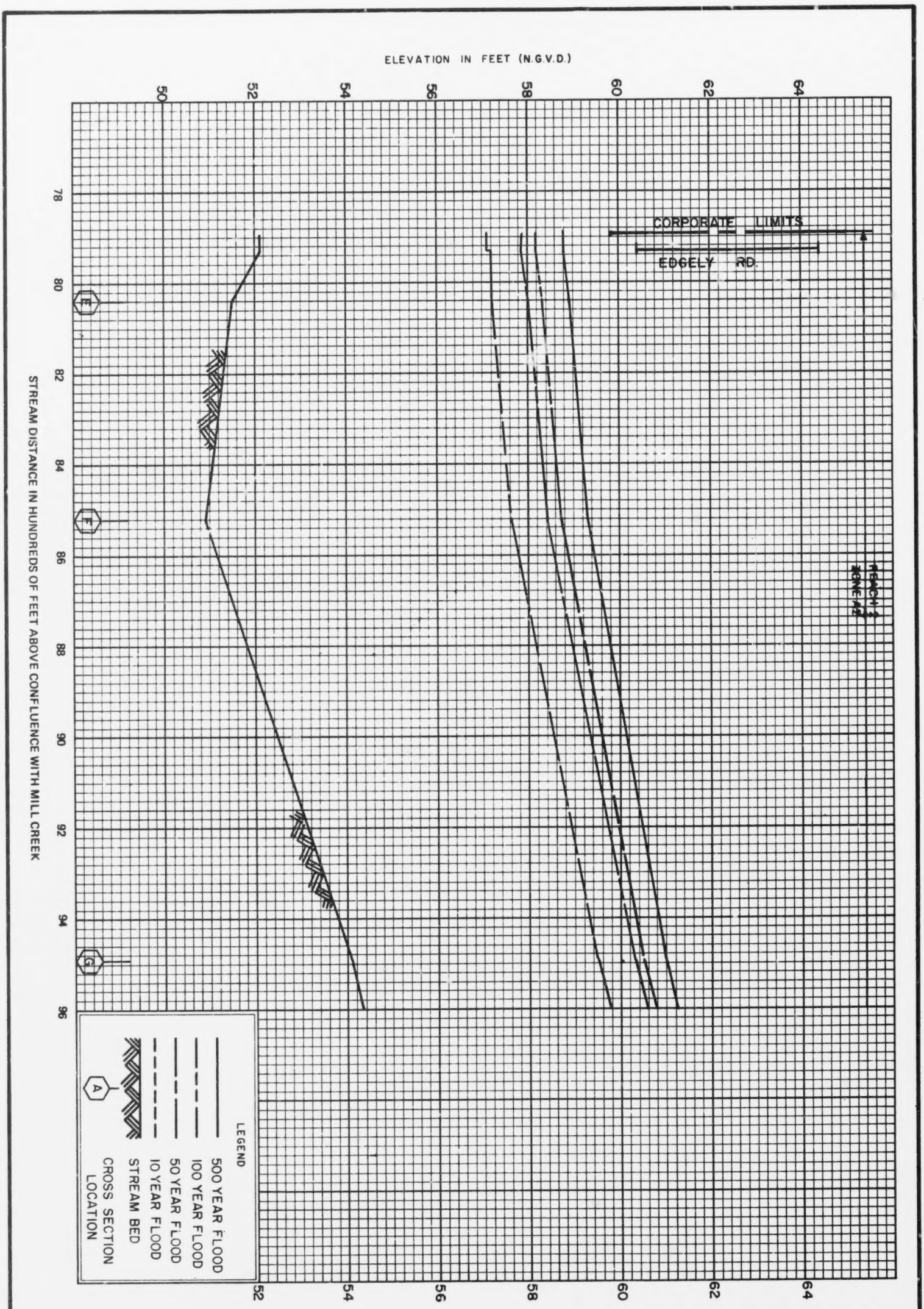

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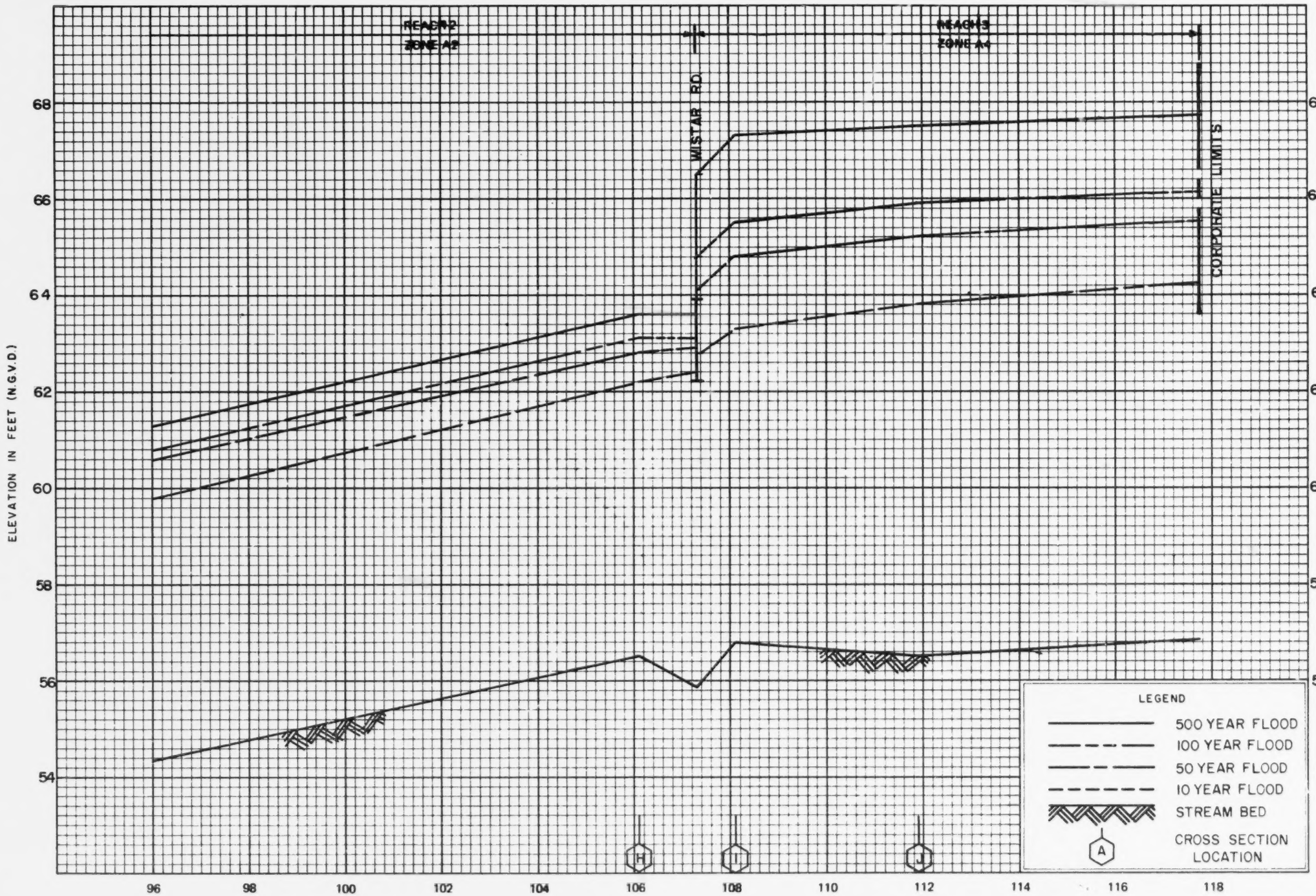


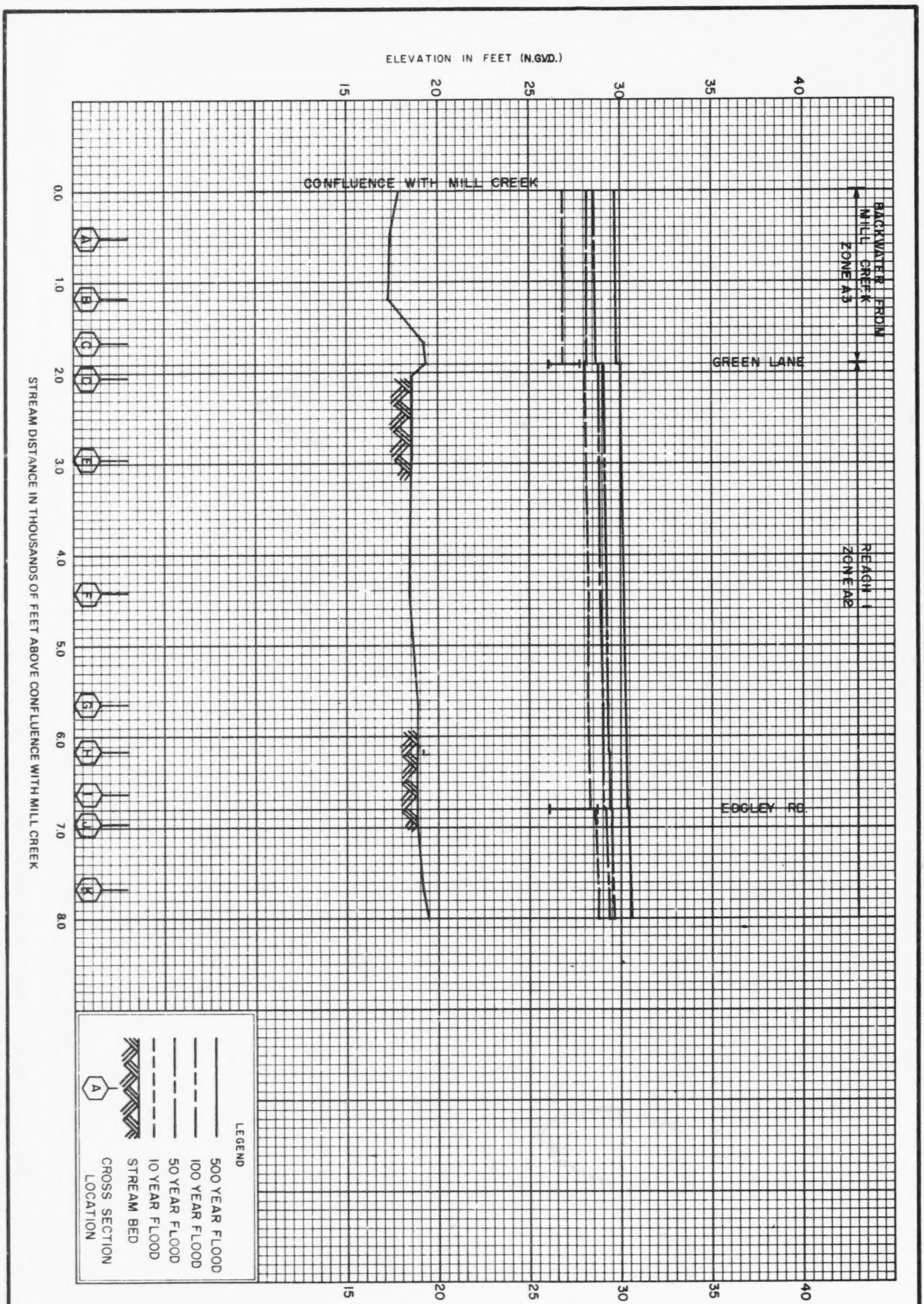
FLOOD PROFILES

QUEEN ANNE CREEK

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA.
(BUCKS CO.)

10P



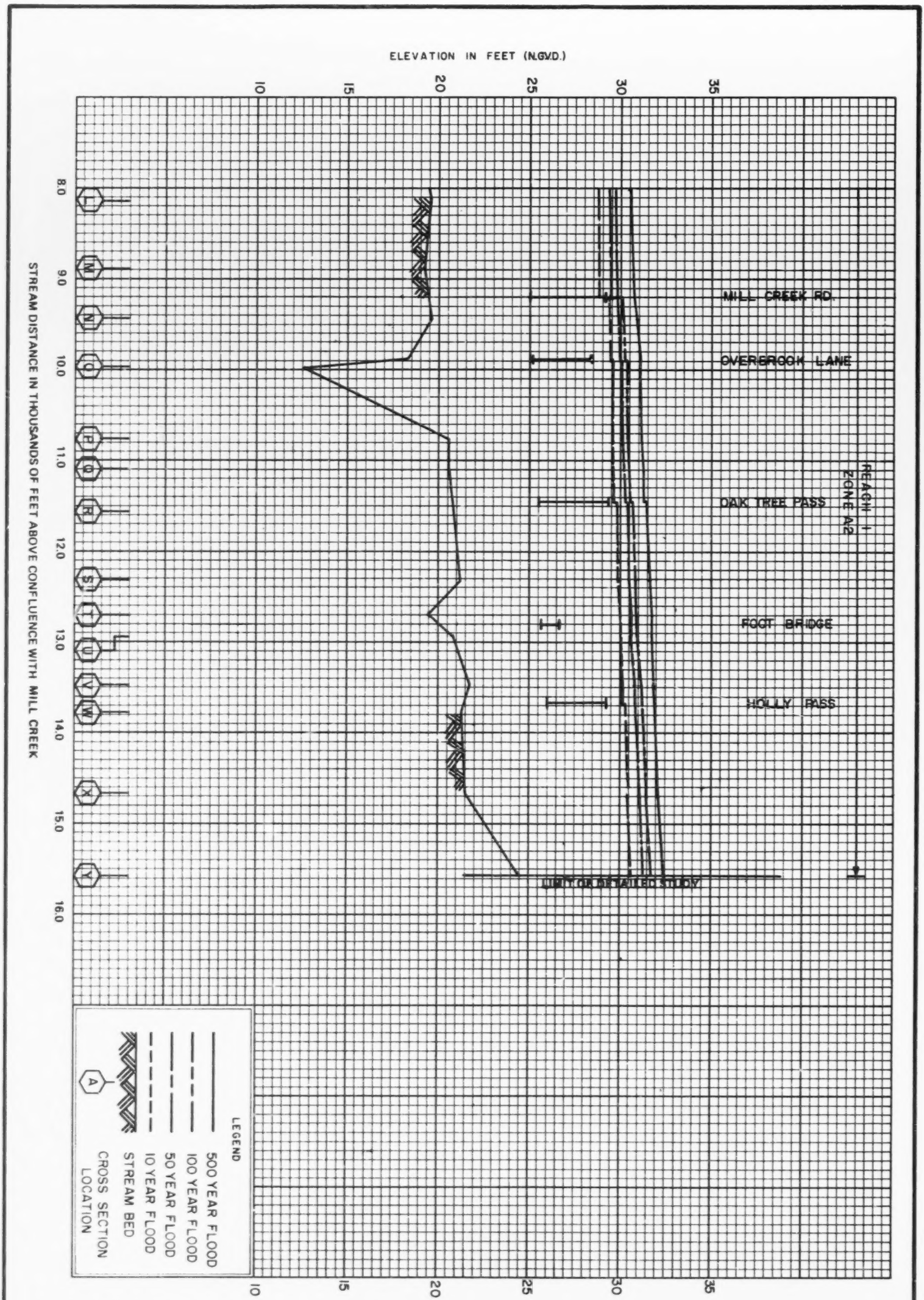
11P

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA
(BUCKS CO.)

FLOOD PROFILES

BLACK DITCH



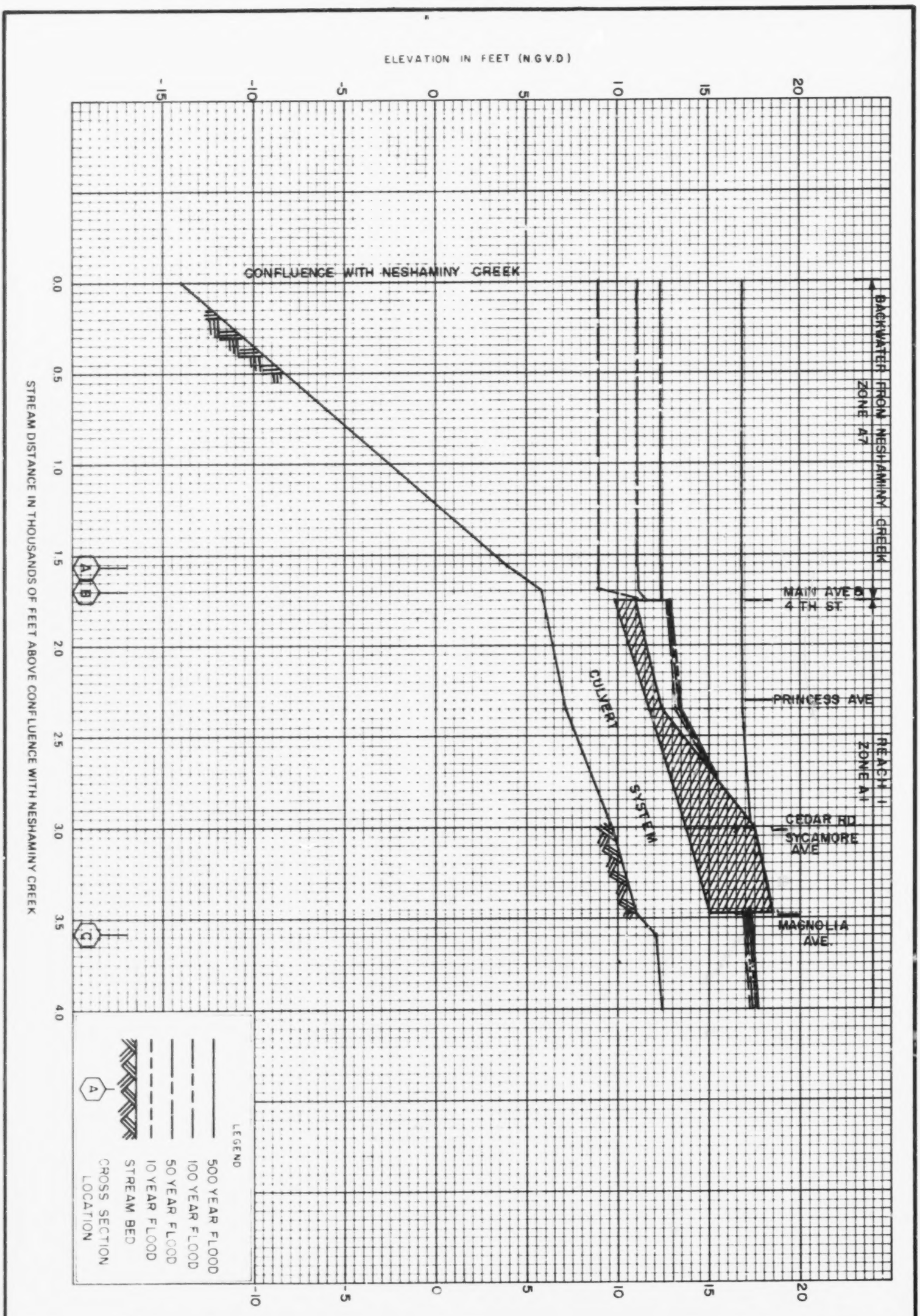
12P

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA.
(BUCKS CO.)

FLOOD PROFILES

BLACK DITCH



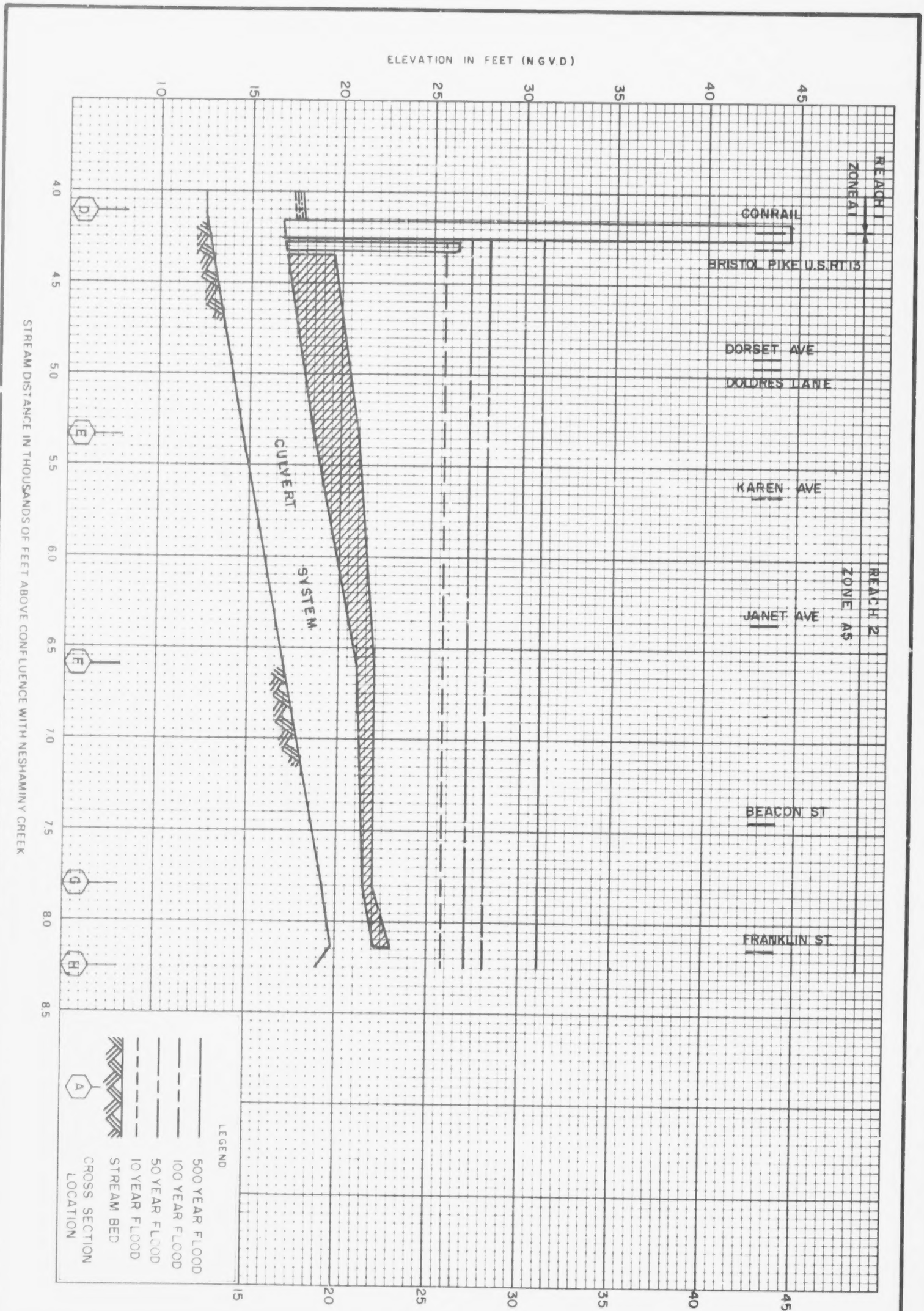
13P

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA.
(BUCKS CO.)

FLOOD PROFILES

CROYDON RUN



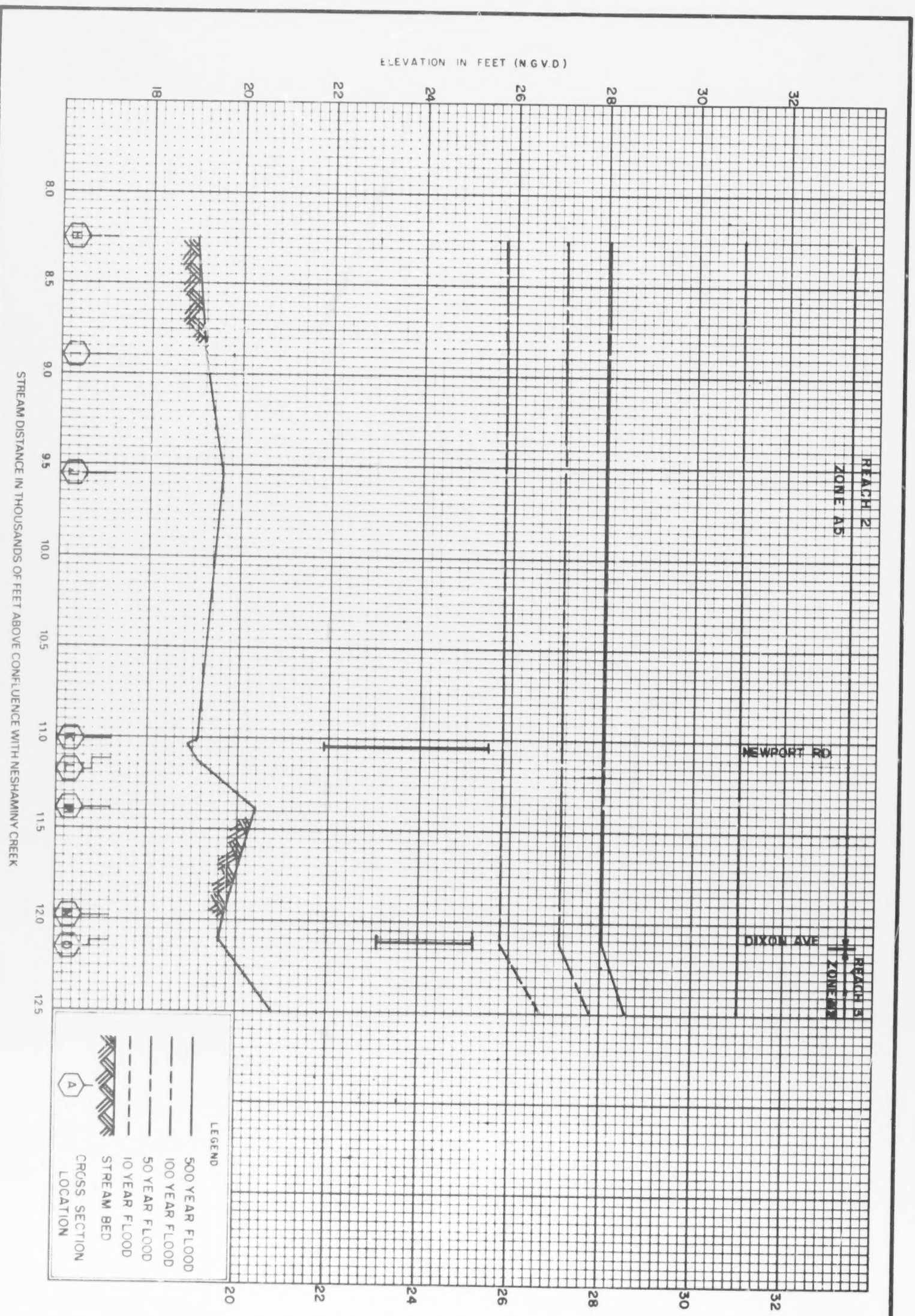
14P

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA.
(BUCKS CO.)

FLOOD PROFILES

CROYDON RUN



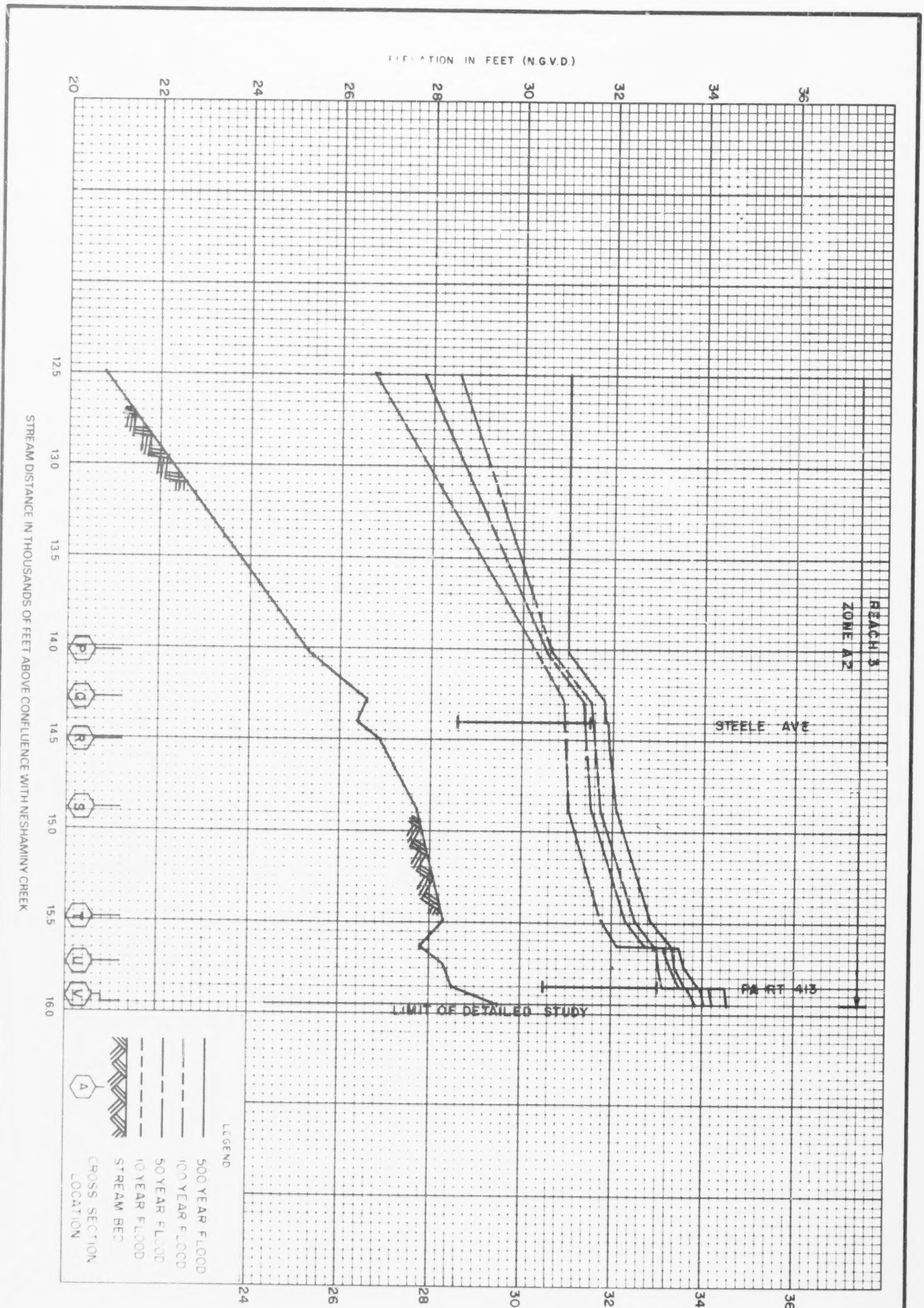
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA.
(BUCKS CO.)

FLOOD PROFILES

CROYDON RUN

15P



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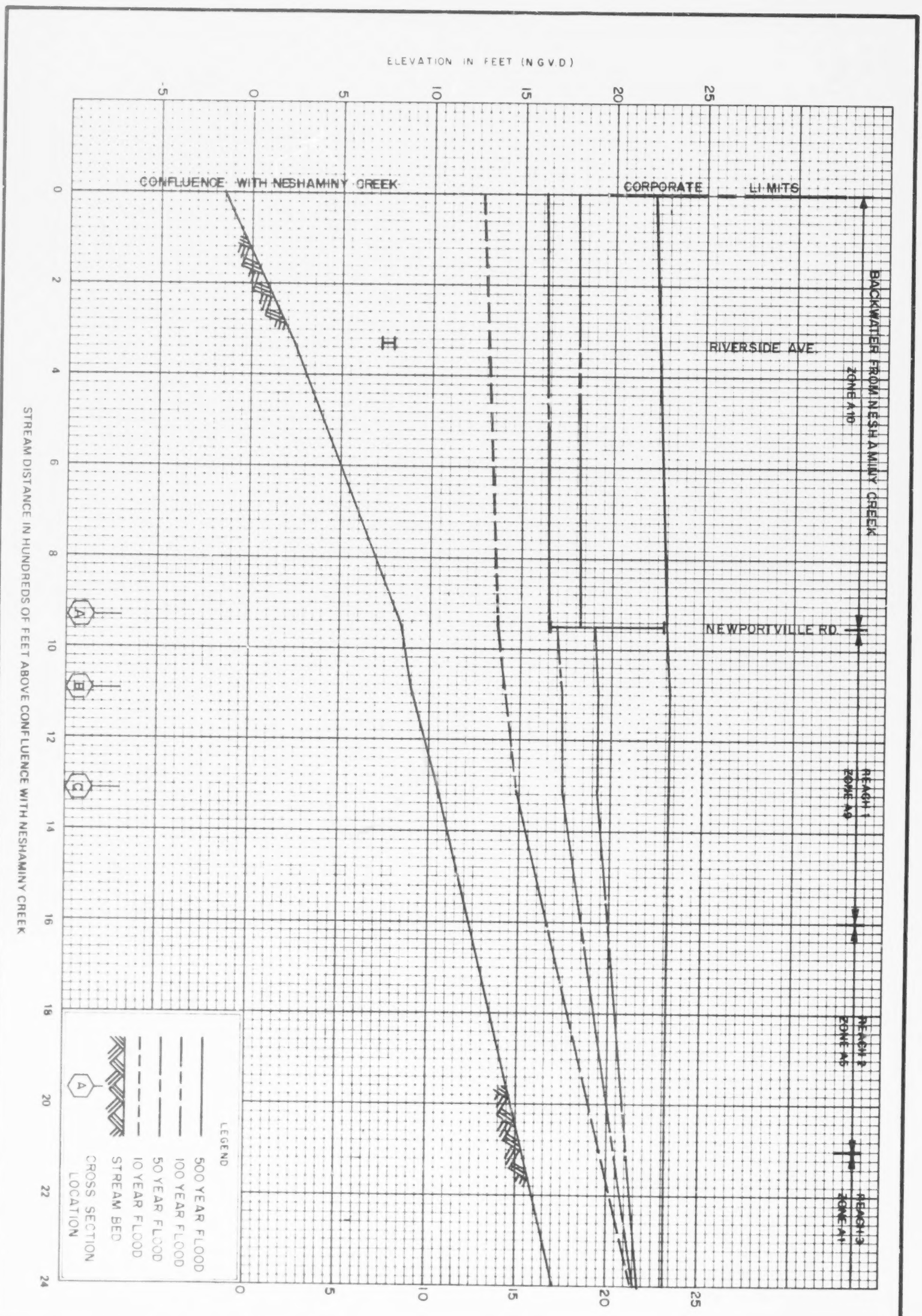


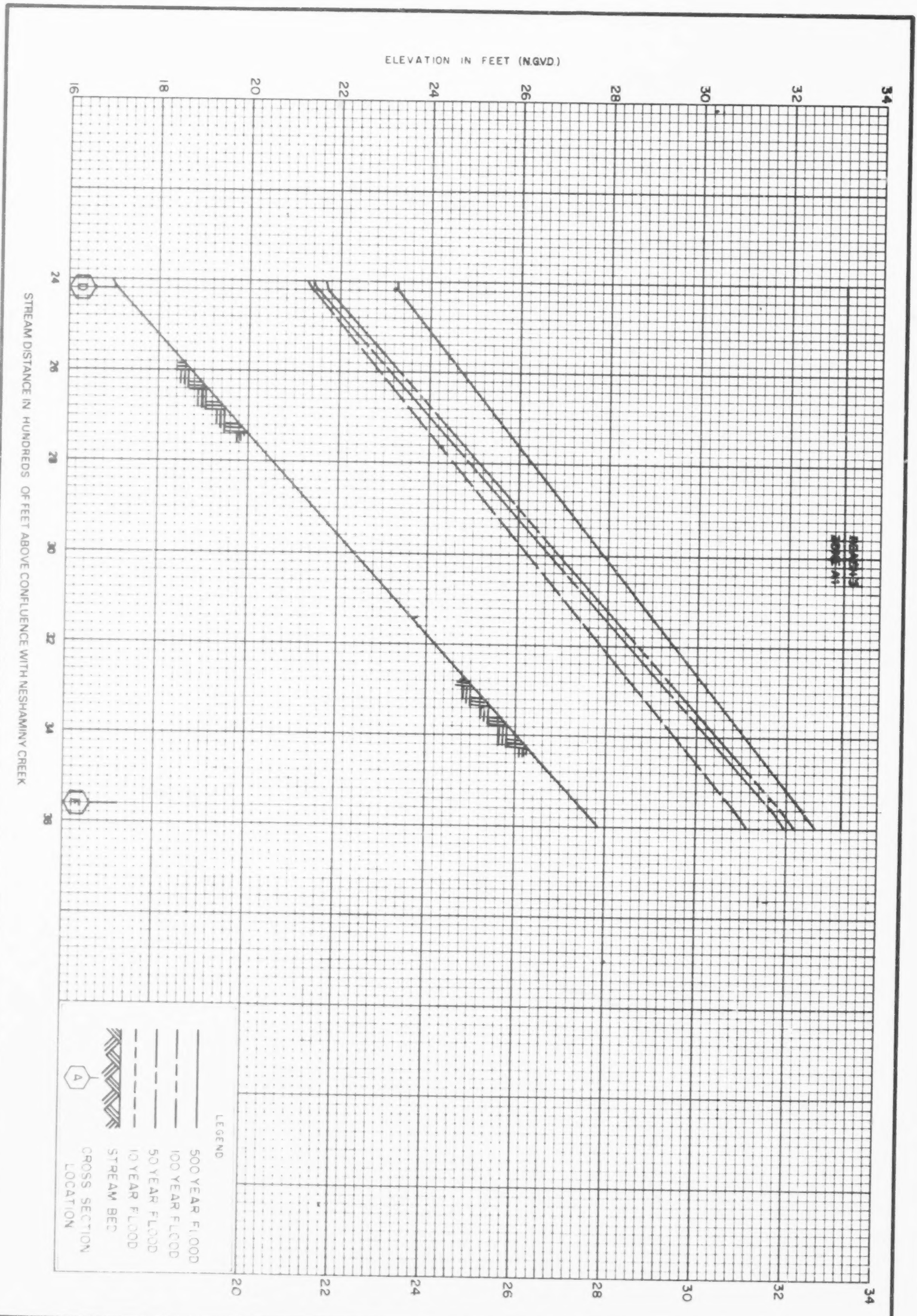
17P

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA.
(BUCKS CO.)

FLOOD PROFILES

QUEEN ANNE CREEK (NEWPORTVILLE)



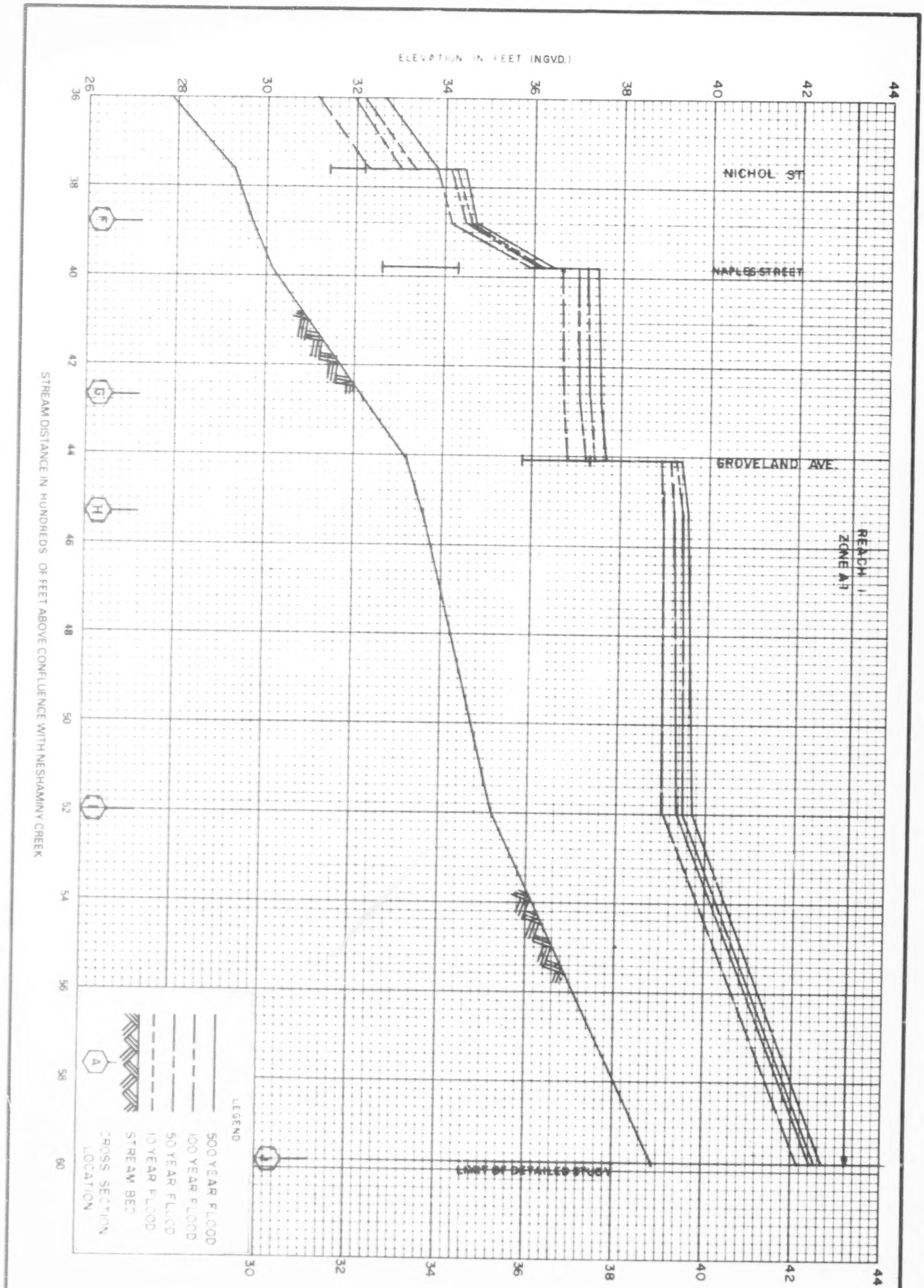
18P

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA.
(BUCKS CO.)

FLOOD PROFILES

QUEEN ANNE CREEK (NEWPORTVILLE)



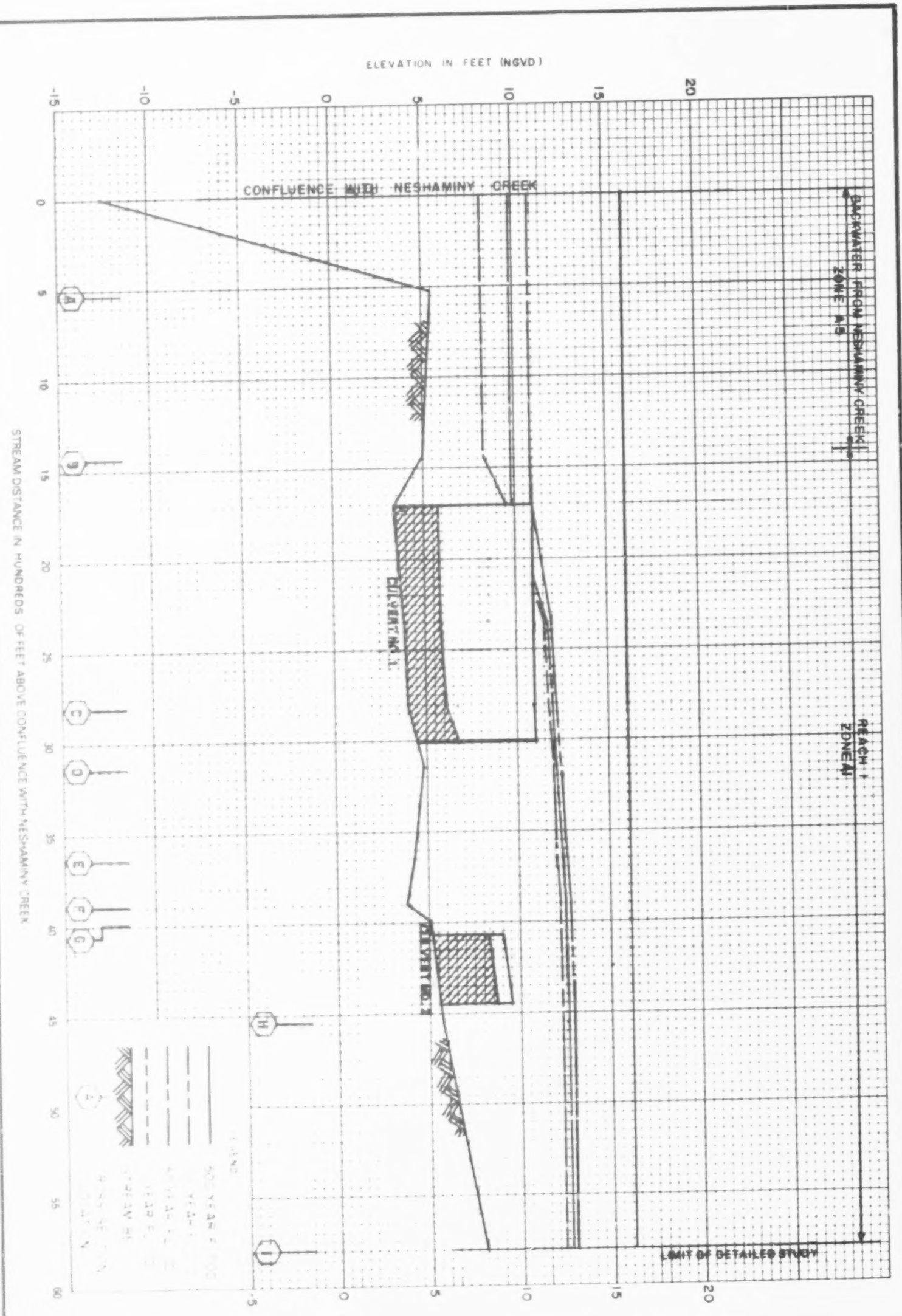
19P

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

TOWNSHIP OF BRISTOL, PA.
(BUCKS CO.)

FLOOD PROFILES

QUEEN ANNE CREEK (NEWPORTVILLE)



20P	DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT Federal Insurance Administration TOWNSHIP OF BRISTOL, PA. (BUCKS CO.)	FLOOD PROFILES CROYDON TRIBUTARY